POWER

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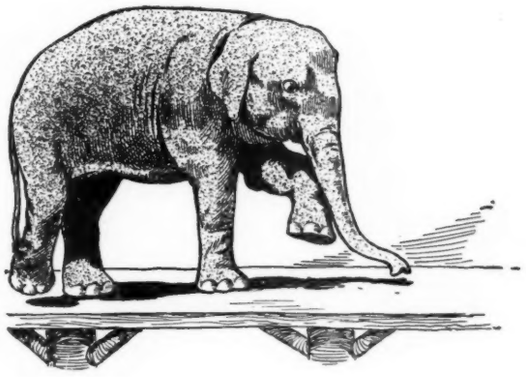

Candid hats

Be Sure of Your Ground

Let us have a heart to heart talk on the central-station-isolated-plant situation

You have seen a circus elephant, crossing a small bridge, test it at every step to make sure that it would sustain his weight. He knows he must be "sure of his ground," for with his great weight a fall is serious. Not so with the lizard. Put him on a table and he will walk blindly off and fall. Having less need of it he has developed no sense of caution.

This central-station-isolated-plant discussion that is so absorbing has on each side of it men who represent the elephant and those who are comparable with the lizard, however good the intentions of the latter. Those with a reputation to sustain are slow about passing opinions. The others either have no reputation or anything else at stake, or they are very careless.

Institutions do not thrive and grow in a community when there is no demand for them. When there is need for any industry it develops until that need is fulfilled and ceases to develop further unless the demand is forced and stimulated by artificial means. It is when these latter tactics are employed that there is a clash of interests in the community. Those who so promote a project, find themselves opposed by those whose interest they have jeopardized. But both sides should recognize that each has a field which it alone can best serve. Each is useful if rightly used. The public knows this and laws and commissions are provided to direct the business of each to this end.

The foregoing expresses the central-station-isolated plant situation.

The engineer must concede that the central station as well as the isolated plant has its field of usefulness. There are places where central-station service is warranted and advisable beyond question. There are others where central service has no possible advantage. These extremes are not debatable, but there are places where it could not be accurately determined without thorough investigation, which kind of service is best. One cannot walk into such a plant and give a snap decision that is worth consideration. Then is the time to emulate the elephant.

As an example of a place of the first kind, take a warehouse where the lighting load is small and uniform, but the elevator load is heavy and widely fluctuating. The plant must be large enough to carry the maximum load and be ready to carry it at all times. These are uneconomical conditions for the isolated plant, and central-station service should prove advantageous if the rate is fair. Salt works, bleacheries, thread and cotton mills, dye houses, etc., are examples of the second kind. The load is fairly constant and there is use for all exhaust steam; mixed-pressure turbines may be installed to advantage. Hotels need exhaust steam for heating in winter and for absorption refrigeration plants in summer.

The plants of the middle class are far more numerous than the others. They are the storm centers. They must be operated skillfully; the engineer must realize that his work here is not a mere job. It is a many-angled business proposition. In selling power, as in selling anything else, advantage must be taken of every legitimate opportunity. The central station does this through trained experts in its various departments. These constitute the competing business forces arrayed against the engineer. This is the condition he must meet.

To meet it successfully he must know what is good practice, how to apply it to his particular plant and to tell how well he is applying it. All this requires more knowledge and more work than formerly. The engineer cannot better matters by vehement protests and wild assertions, but he can, by attacking the problem rightly—by being "sure of his ground," like the elephant. When individually, he feels the need of a consulting engineer he should see to it that he gets a good one.

The sources of helpful information are many. There are the power-plant papers, cheap but good bound books, engineers' organizations, with their lectures and general educational work (altogether too much neglected by the rank and file), public libraries, schools, many of them free, and, lastly, the plants of engineer friends.

It is told that King Alexander, when a student, asked his instructor if there was no short cut to algebra. The good instructor replied that there was no royal road to mathematics. There isn't. It's hard plugging. And so it is with good power-plant engineering.

Producer Gas for Industrial and Power Purposes

By Thomas Wilson

SYNOPSIS—This is a producer plant, with special control features, which supplies gas under suction and under pressure for power and industrial purposes.

Within the last few years the use of gas for heating purposes in many industries has greatly increased. Cleanliness and convenience and the ease with which it can be controlled so that the temperature can be closely regulated have been the deciding factors. Natural and city gas have been used to good advantage, but for low-temperature work up to 2000 deg. F. anthracite producer gas has given equal satisfaction at a much lower cost.

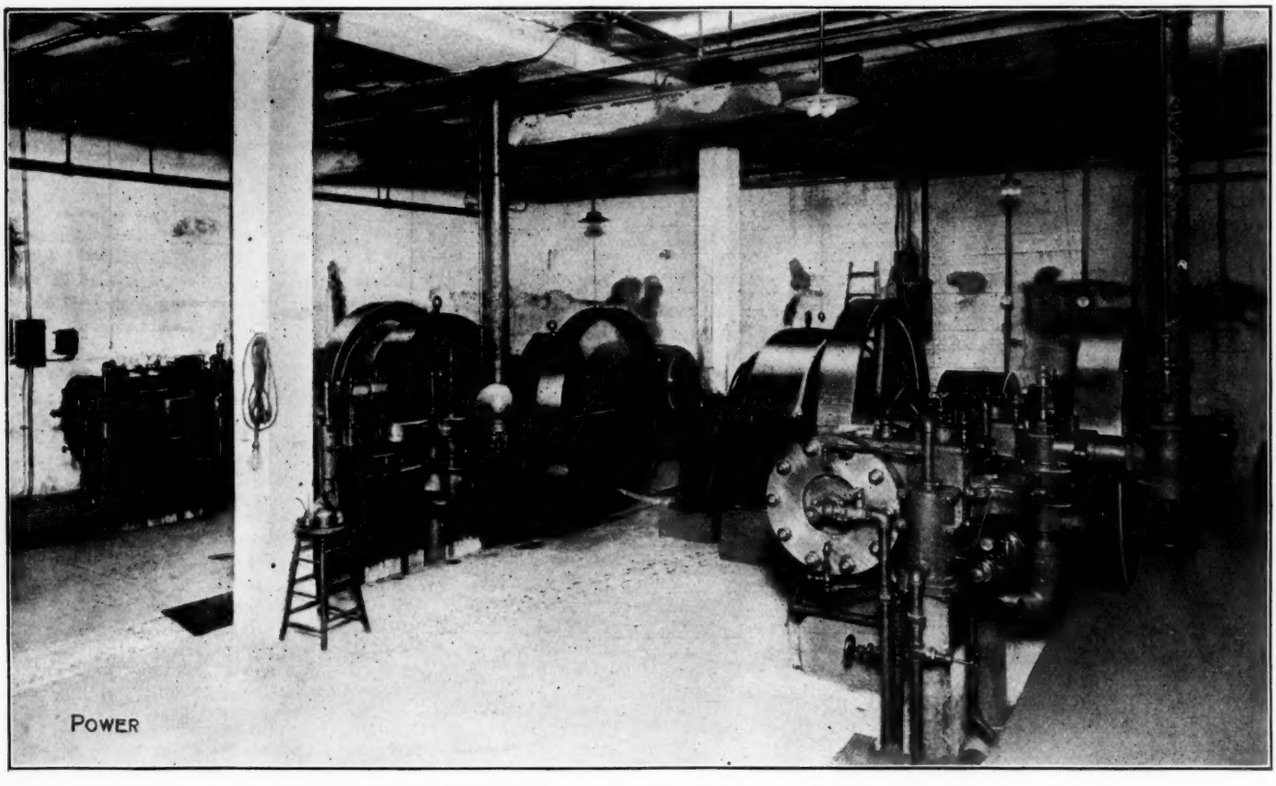

Fig. 1. Gas-Engine Plant at Barnhart Brothers & Spindler

The cost item has induced manufacturers to install gas producers using inferior grades of anthracite to supply gas, not only for heating purposes, but for power.

A plant involving this double service has been installed in the new factory of Barnhart Brothers & Spindler, Chicago, makers of type and printers' supplies. The new building, measuring in plan 200x236 ft., has two stories and a basement and over 100,000 sq.ft. of floor space. The gas is used for melting the metal in type-casting machines, for hardening furnaces, machine torches, brazing torches, for lead and slug casting, in annealers, copper- and nickel-plating baths, etc. About 70 per cent. is required for these purposes and the balance by the engine units generating current for power and lighting.

There are 70 type-casting machines, each equipped with individual motors. All chases are electrically welded, for which fully 75 hp. is required. A machine shop in which the factory machines are made and repaired takes considerable power; besides, there are electrically driven pumps and fans, and an elevator and conveying machinery to move the product in the course of manufacture. When the plant is running to full capacity, with the chase department in operation, the load will average close to 150 kw., and when chases are not being welded it will drop off one-third. Consequently, two units have been installed, one a 125-hp., 17¼x16-in., four-stroke-cycle tandem gas engine directly connected to a 75-kw. direct-current generator, and the other a twin engine of the same type and size of cylinders driving a 150-kw. generator; the speed in each case is 250 r.p.m. These machines are operated 10 hr. a day, and it is the plan to use them alternately, depending on the welding periods. The plant also has a breakdown service, but so far it has been called on only for night lighting, for the fire pumps and for starting the blower run in connection with the two producers of 350 hp. each.

As the plant has been running only a short time no satisfactory records are available, but it may be said that the gas, which averages about 145 and has reached 151 B.t.u. per cubic foot, has given excellent satisfaction both for heating and power purposes. About 95 lb. of

buckwheat No. 1 in the producer is equivalent to 1000 cu.ft. of natural gas containing 800 B.t.u. per cubic foot, and 75 lb. is equivalent to the same quantity of city gas containing 550 to 600 B.t.u. At $5 per ton, which is a high charge for such coal in quantities, the fuel cost would be 24 and 19 cents, respectively. To this must be added the labor item and the interest and depreciation on the producer installation; even then the total cost does not exceed much more than one-third the usual charge for city gas. In a preliminary estimate, the equivalent of 1000 cu.ft. of city gas was figured to cost 31.3c., including a charge for water and interest and depreciation amounting to 16 per cent. For the engines the guarantee was 1⅛ lb. of buckwheat No. 1 per brake horsepower-hour at full load, which at $5 per ton gives a fuel charge of 0.28c. This amount will generate about 79 cu.ft. of producer gas, and with a heat content of 145 B.t.u. will supply 11,455 B.t.u. per boiler horsepower-hour

The Producer Plant

In this department each of the two Flinn & Dreffein units is rated at 350 hp. and consists of a producer and an economizer; a scrubber serves the two generators. The producers, of the water-sealed type, have a heavy steel shell 8 ft. in diameter by 12 ft. high, firebrick lined, and rest on legs in a concrete pan. The fuel is supported on a layer of ashes on the bottom of the pan. Between the bottoms of the shell and the pan there is a clearance of 12 in., and as the pan diameter is greater than that of the shell, there is room for removing the ashes, which are placed in 400-lb. cans, hoisted to the street level and carted away.

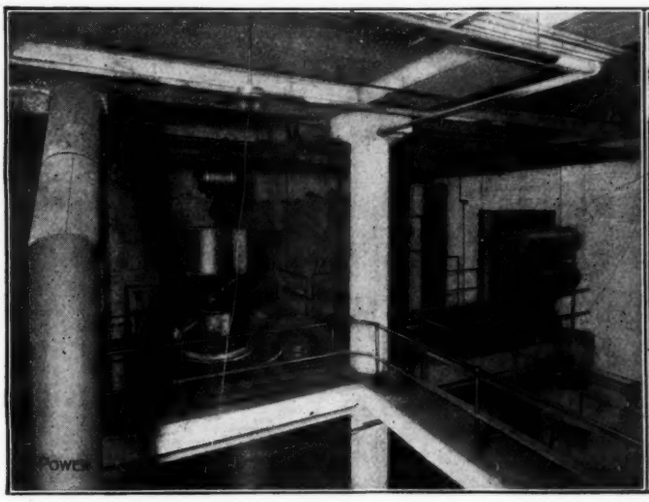

Fig. 2. Charging Floor of Producers

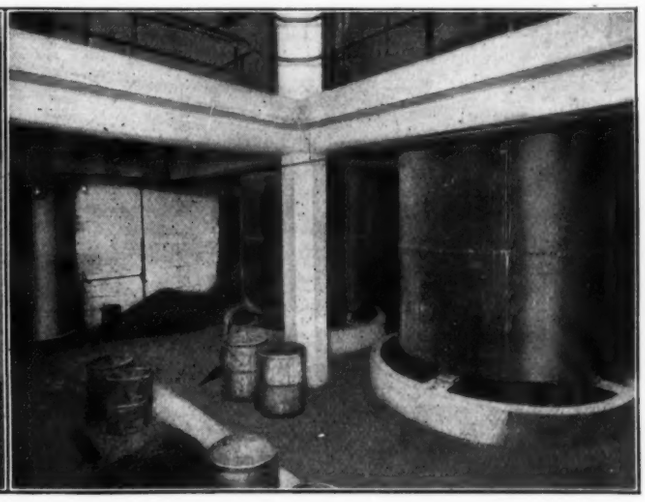

Fig. 3. Bottom of Generators and Steam Boiler

Coal from a 100-ton bunker below the street level is delivered by gravity through a chute into the bucket of a one-ton electric monorail hoist, which for feeding can be moved directly over the hopper of each producer. At their rated load the two require 750 lb. of coal per hour, although they are now running at only two-thirds capacity. The producers are not charged heavily, but are fed uniformly with 150-lb. charges at 35-min. intervals. The hoist bucket easily holds ten charges, and is usually filled four times each day.

The coal enters the producer through a double-seal hopper, a counterweighted bell at the bottom of the hopper preventing the admission of air while the coal is being fed. The sliding plate at the top is closed while the bell is lowered, so that the coal may run down over it and be evenly distributed over the fuel bed. The hopper rests on a water-cooled top having poke holes for attending to the fuel bed.

A feature of the producer is the annular tuyere of dog-house cross-section, which uniformly distributes the air and steam to the fuel bed. This construction facilitates the ash removal, as the ashes can drop around or within the annulus and easily reach the concrete pan at the bottom.

An important part of the plant is the economizer, which in the present installation is 9 ft. high and 42 in. diameter, and consists of two concentric steel shells forming two chambers. The gas from the generator passes through the inner one and gives up part of its heat to the air flowing in the opposite direction through the outer chamber to the fuel bed. Ordinarily the gas leaves the producer at 1200 deg. F., and if it passed directly to the scrubber it would carry about 12 per cent. of the heat in the coal. By raising the temperature of the air to 500 deg. in the economizer two-thirds of this heat is reclaimed.

In the pipe connection between the top of the outer chamber and the tuyere of the producer, a steam blower is inserted to saturate the air and equalize the pressure in the top of the producer; otherwise, there would be a slight depression caused by the suction of the engines and of the blower supplying the shop equipment. Atmospheric pressure is thus maintained so that there is no tendency for air to be drawn in or gas to be blown out through the poke-holes when attending the fuel bed.

With the air at this high temperature, combustion is facilitated and the steam is carried to the fuel bed without condensation; it is also claimed that a richer gas is thereby obtained. The steam is supplied by a small vertical fire-tube boiler rated at 15 hp. and having a pressure of 50 to 80 lb., depending on the load the producers are carrying. The quantity of steam is controlled by a gasometer connected by block-and-tackle to a weighted lever attached to the stem of the balanced steam valve. The gasometer connects with the top of the producer. As

the load increases, the gas pressure tends to drop, so that the gasometer lowers slightly, and, through the connecting links, increases the opening of the steam valve. A drop in load produces the reverse results.

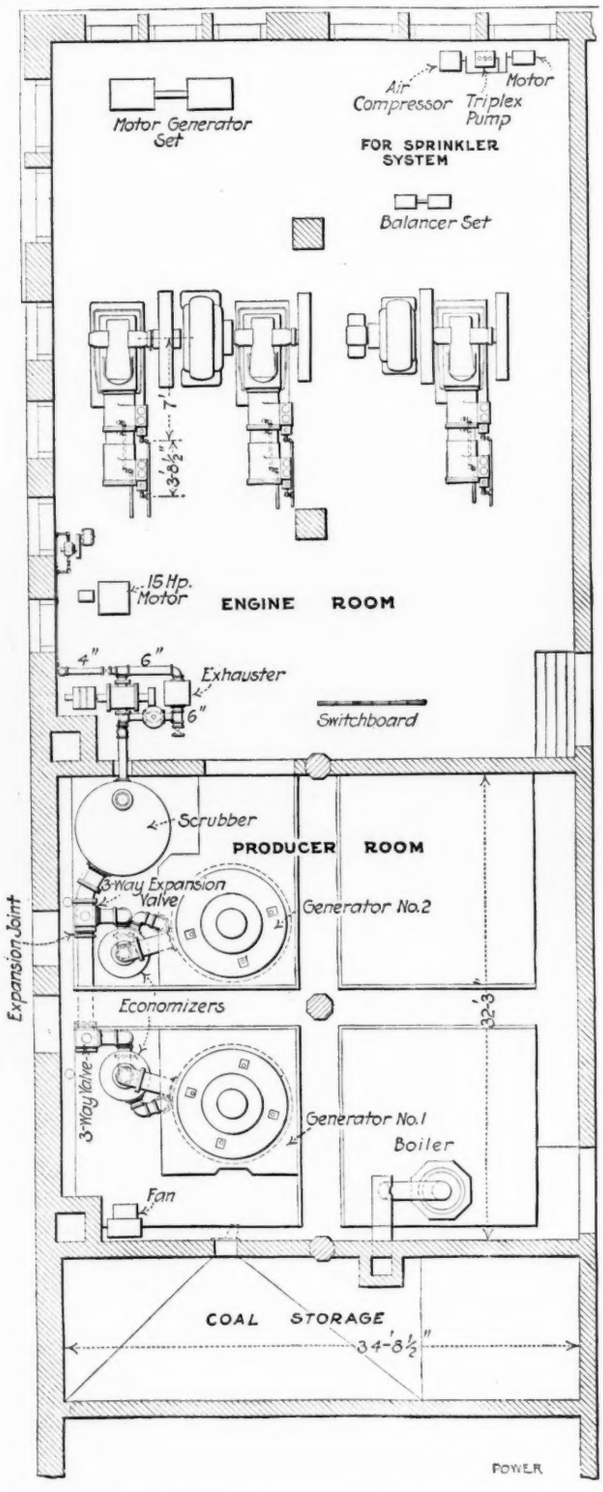

FIG. 4. PLAN VIEW OF ENGINE AND PRODUCER ROOMS

From the economizer to the wet scrubber the gas passes through a three-way water-sealed valve from the top of which the purge pipe leads to the roof. Water sealing the valve eliminates any possible trouble from tar and soot sticking to a dry seat and makes the tightness of the valve more certain. The scrubber serving the two units is 6 ft. 6 in. in diameter by 22 ft. high, and contains a coke column supported on trays, water sprinklers above, and at the top a layer of excelsior to remove the moisture.

From the scrubber the gas is drawn directly to the engines by the suction of the pistons. As for industrial purposes, it is necessary to supply the gas at a definite and uniform pressure; there is an exhauster belt driven by a 15-hp. motor. Instead of using a gas holder, a pipe connection is made between the delivery and suction sides of the exhauster. In this line is a back-pressure valve weighted for the desired pressure; when this exceeds the predetermined value, the valve opens and returns part of the gas to the suction side of the exhauster. The latter is run at constant speed so that the maximum output will be available. To the valve spindle is attached a diaphragm subject to the pressure in the gas main, and opposing this are weights on the upper side of the diaphragm. The construction is such that the diaphragm casing may be rotated at will, pulling

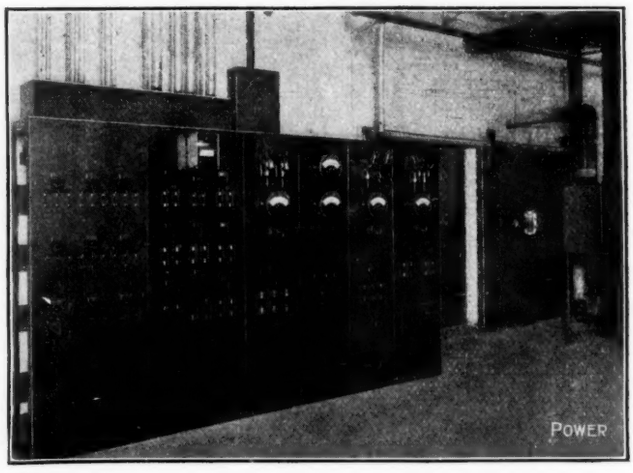

FIG. 5. SWITCHBOARD, STATIC WASHER AND EXHAUSTER

with it the valve disk and thus keeping it free from soot or deposit by the grinding action on the seat.

For the engines, the gas is clean enough as it comes from the wet scrubber, but for small burner work it must also be passed through a static washer operating on the impact principle. The washer, Fig. 6, consists of a chamber having two compartments, the upper one giving space for gas admission and a spray of water. Hanging from the dividing wall is a threaded cylinder with a piston having threads of the same pitch, but not in contact with those of the cylinder wall. Both are so tapered that as the piston is moved downward the flow area is lessened and the velocity of the gas is increased, or *vice-versa*. The stem attached to the piston has threads of the same pitch also, so that in moving the piston up or down there is no variation in the "mesh."

In passing through this zigzag course, the remaining soot particles in the gas are deposited on the metal surfaces and washed down through the drain at the bottom of the lower compartment. The purified gas passes on to the burners.

ENGINE ROOM

The engines are of the tandem type directly connected to 110-, 220-volt, three-wire generators, with a balancer

set. Rites inertia governors acting through balanced cut-off valves control the speed, and under the severe conditions imposed by the welding department they have maintained close regulation.

The plant is distinctive in design in that any part of either engine, with the exception of the crankshafts and flywheels, is interchangeable, and either half of the twin engine can be run independently of the other. In this way, one tandem unit can be out of service and the other two will be available to furnish the maximum load of 150 kw.

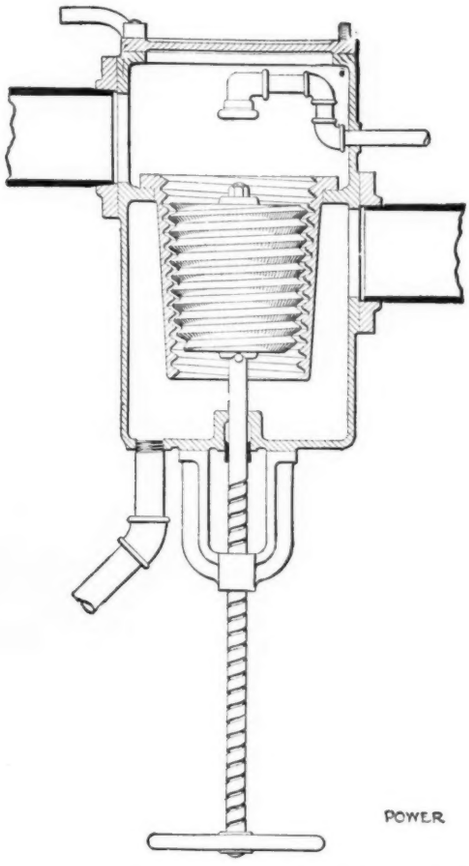

FIG. 6. SECTIONAL VIEW THROUGH STATIC WASHER

A 10-in. pipe from the scrubber, with 6-in. taps to each tandem unit, supplies the gas to the engines. From the twin engine, two 6-in. exhaust pipes discharge to a 12-in. muffler; this reduces to 8 in. as it leads to the roof. The single tandem engine has a 6-in exhaust, a 10-in. muffler and a 6-in. riser.

Air for starting is stored in two 30-cu.ft. tanks at 200-lb. pressure during the day by a motor-driven compressor. From a 5000-gal. tank on the roof cooling water flows through the engine jackets and then to the suction of a 2-in. motor-driven centrifugal pump which returns it to the tank through a cooling tower above the tank. In case of accident to the pump, city water will be used temporarily.

Other equipment includes a pump and air-compressor unit for the sprinkler system, a motor-generator set to supply current of the proper voltage for welding, two bilge pumps to raise the sewage to the necessary level and a triplex pump to circulate water through the type-casting machines.

For heating the building, two water-tube boilers, each able to serve 10,000 sq.ft. of radiation, supply steam at a 5-lb. pressure to a vacuum system having 16,000 sq.ft. of radiation. A steam plant was first considered, but because of the low efficiency in summer, of insufficient exhaust steam to supply the heating for at least part of the winter, and because gas was needed in the shop, the present plant appeared to be the best, considering its brief period of operation, and nothing has happened to gainsay this decision. The gas for both services has given satisfaction, and, from the meager data available, the cost has been exceptionally low.

C. R. Murray is the general superintendent of the works and O. G. Schmitt is the mechanical engineer for the company.

PRINCIPAL EQUIPMENT OF BARNHART BROTHERS & SPINDLER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Gas generators	Water sealed	8 ft. dia, 12 ft. high	Produce gas for heating and power	Atmospheric pressure in top of producer	Flinn & Dreffein Co.
2	Economizers	Counterflow	42 in. dia., 9 ft. high	Heat air to generator	Gas 1200 deg. F., air 500 deg. F	Flinn & Dreffein Co.
1	Scrubber	Wet	78 in. dia., 22 ft. high	Clean gas	Coke, water and excelsior	Flinn & Dreffein Co.
1	Boiler	Vertical fire tube	15 hp.	Steam to generators	50 to 80 lb. pressure	S. Freeman & Sons
1	Coal hoist	Electric	1 ton	Coal from bunker to generators	Motor driven	Sprague Electric Works
1	Blower	Positive	No. 5	Gas under pressure to burners	Belted to motor, 400 r.p.m.	B. F. Sturtevant Co.
1	Motor	Direct current	15 hp.	Drive blower	220 volts, 800 r.p.m.	Crocker-Wheeler Co.
1	Gas engine	Tandem, four-cycle	125 hp., 17¼x16 in.	Main generating unit	Producer gas, 250 r.p.m.	Alberger Gas Engine Co.
1	Generator	Direct current	75 kw.	Main generating unit	110-220 volts, 250 r.p.m.	Crocker-Wheeler Co.
1	Gas engine	Twin tandem	250 hp., 17¼x16 in.	Main generating unit	Producer gas, 250 r.p.m.	Alberger Gas Engine Co.
1	Generator	Direct current	150 kw.	Main generating unit	110-220 volts, 250 r.p.m.	Crocker-Wheeler Co.
1	Pump	Centrifugal	1½ in.	Cooling water for gas engines	Motor driven	Goulds Mfg. Co.
1	Motor	Direct current	5 hp.	Drives circulating pump	220 volts, 2200 r.p.m.	Imperial Electric Co.
1	Air compressor	Vertical	3x3½ in.	Starting gas engines	200 lb. pressure, 400 r.p.m.	Gardner Governor Co.
1	Motor	Direct current	3 hp.	Geared to air compressor	220 volts, 1300 r.p.m.	Crocker-Wheeler Co.
1	Motor	Direct current	75 hp.	Drive welding generator	220 volts, 1050 r.p.m.	Crocker-Wheeler Co.
1	Generator	Single-phase A.C.	50 kw.	Current for welding	450 volts, 1050 r.p.m.	Thomson Electric Welding Co.
1	Balancer set			Balance three-wire system	50 amp., 110 volts, 1650 r.p.m.	Crocker-Wheeler Co.
1	Pump	Triplex	6x9 in.	Water to sprinkler system	Geared to motor	The Lucas Pump Co.
1	Air compressor		8x3½ in.	Air to sprinkler system	Geared to motor	Allis-Chalmers Co.
1	Motor	Direct current	25 hp.	Drives pump and air compressor of sprinkler system	220 volts, 1650 r.p.m.	Sprague Electric Works
1	Pump	Triplex	5x6 in.	Cooling water for casting machines	Chain drive to motor	The Deming Co.
1	Motor	Direct current	5 hp.	Drive triplex pump	220 volts	Sprague Electric Works
2	Pumps	Bilge	No. 5	Raise sewage	150 gal. per min., 30 ft. head, motor driven	Chicago Pump Co.
2	Boilers	Low-pressure, water tube	10,000 sq.ft. radiation	Heat building	5 lb. pressure	Hart & Crouse Co.
1	Pump	Vacuum	5x7 in.	Heating system	Belted to motor	Warren Webster & Co.
1	Motor	Direct current	4 hp.	Drive vacuum pump	220 volts, 1150 r.p.m.	Sprague Electric Works

Boiler Feed-Water Expurgator

A system for the purification of water for boiler purposes has been placed on the market recently. To obtain the catallactic action, the treating member, known as the expurgator, is placed in the feed pipe, preferably between the heater and the boiler. The water passes through the large connection on the upper left side of the expurgator into a channel, Fig. 1, which, becoming smaller on approaching the bottom, increases the pressure of the water until it arrives at the bottom or narrowest point. There the water is at its highest pressure and comes in contact with the protruding lip of the left wall of the hopper, thereby causing a rotary suction back of the lip.

This suction draws a continuous stream of treating material, consisting of granulated particles of metal

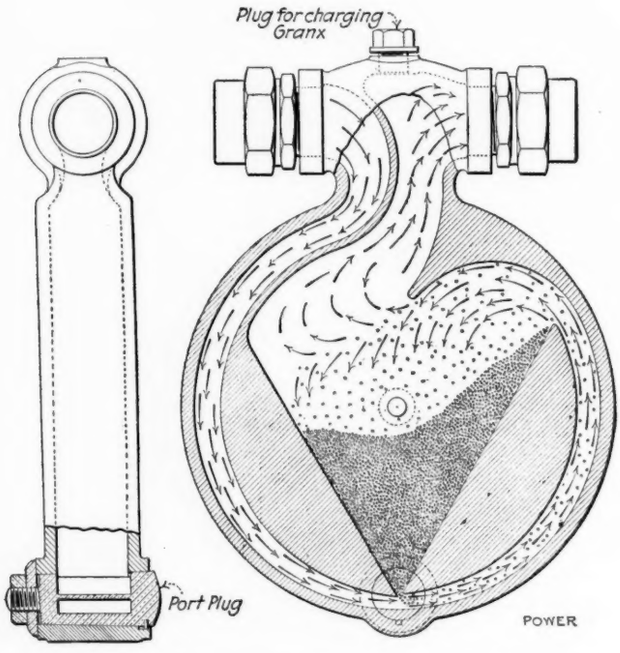

FIG. 1. SECTION THROUGH BODY OF THE EXPURGATOR

known as granx, from the hopper through the small opening at the bottom into the water. Owing to the high pressure, the granx is agitated until it emerges from the channel. When the water is diverted by a curved deflector on the top of the outside wall of the channel with the center of the hopper, where the granx, having been carried by the water, fall by their own weight back into the hopper, thereby preventing the same from continuing in the outflow into the boiler.

About every thirty days the expurgator is charged with granx through a small hexagon plug at the top. The treated water passes into the boiler and the impurities and substances are brought to the surface by the water circulating in the boiler, where the skimmers, Fig. 3, draw in these impurities and foam through perpendicular pipes into the settling chamber.

These skimmer heads are shaped according to the type of boiler in which they are used, and somewhat resemble a flattened megaphone. The lower side of the skimmer head is always sumberged and the upper side open, to pick up all impurities brought to the mouth of the skimmer by the water. Owing to the height of this opening, the water may rise or fall the limit of the boiler without affecting the skimming operation.

On passing through the pipe into the settling chamber, the water enters the large receiving pipe surrounding the return pipe and, going down the outside, comes in contact with an inverted cone, which diverts the heavier-than-water substances out toward the side of the settling chamber, while the lighter-than-water substances pass upward to the top. The heavier substances continue to fall, passing a second cone at the head of the return pipe and, being diverted to the sides, settle to the V-shape bottom of the settling chamber Fig. 2.

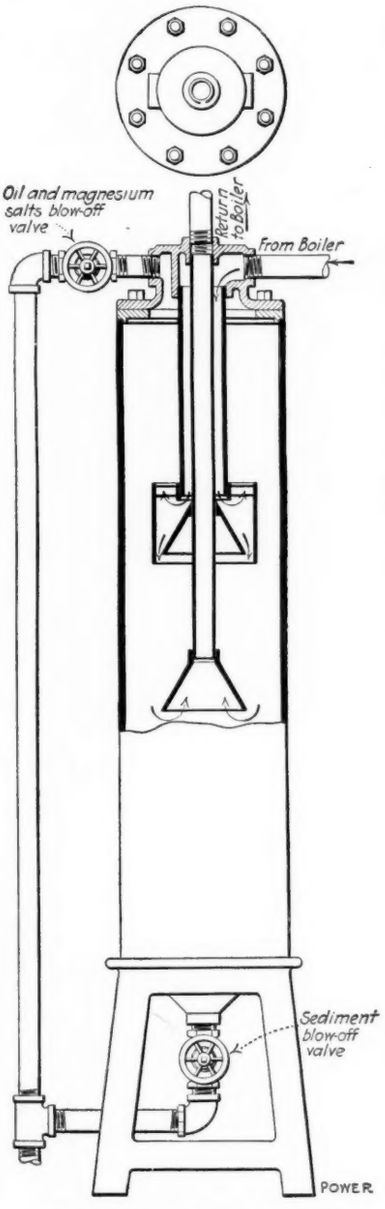

FIG. 2. SETTLING CHAMBER

The clean water travels through the center of the lower inverted cone and into the middle or return pipe, and back into the boiler. This circulation is constant, and the suction is not great enough to return the substances or foreign matter, which are constantly settling to the bottom of the chamber where the accumulation can be blown off.

The valve at the top allows blowing off the lighter-than-water substances in the same manner: it can be done whenever the amount of sediment found demands it.

As the system is automatic, it requires no attention. An expurgator capable of handling up to 250 hp. is about 18 in. across the face and 4 in. thick; it can be placed anywhere in the feed line convenient to the boiler. The settling chamber is about 16 in. in diameter, about 6 ft. high, and can be placed at any of the small places about the boiler.

In the catallactic action brought on through attrition, old scale is attacked from its surface and is softened

slowly. The boiling water removes this softened surface through friction in particles which are picked up by the circulation and carried to the mouth of the skimmer head, and through it to the settling chamber.

The purpose of the system, which is built by the Water Expurgating Co., 42 Broadway, New York City, is to

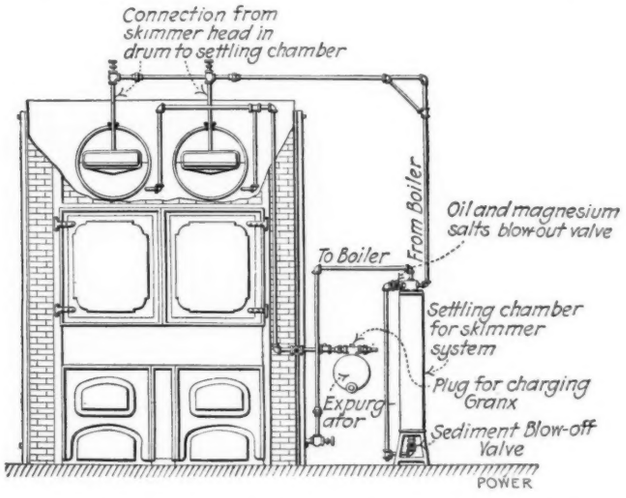

FIG. 3. ARRANGEMENT OF SKIMMER, EXPURGATOR AND SETTLING CHAMBER

saturate the water through attrition, thereby causing the desired catallactic action, thus preventing any of the scale-forming substances from adhering, when they pass into the boiler.

New Combined Thesis

BY PERRY CASSIDY*

The complete design of a 15,000-kw. power plant has been finished as a thesis by the 1914 class of the College of Mechanical and Electrical Engineering, State University of Kentucky.

The problem of the location and design of such a station to furnish light and power to the mining districts of eastern Kentucky and for manufacturing and lighting in the central part of the state, was taken up in conjunction with the class in power-plant design early in January. After careful study, it was found that Valley View, on the Kentucky River, would be an ideal load center, but the cost of shipping coal from the eastern fields of Kentucky would be $1.25 per net ton. The question then arose whether it would not be more economical to build the plant in the center of the coal fields and use a high-tension transmission system to bring the current to a small central switching station at Valley View.

Upon investigation, Hazard, in Perry County, was found to offer good facilities for the plant. There are several large coal mines a mile of two from the town, the Lexington & Eastern R.R. and the north fork of the Kentucky River meeting at that point. The yearly cost of a transmission line from Hazard to Valley View and a switching station at Valley View was found to be sufficiently less than the difference in cost of fuel at Hazard and Valley View to warrant the building of the plant at the former place.

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In March, the senior class was sent to Hazard to make an investigation of conditions affecting the design of a power plant. A report was made by the students on the quantity, quality and cost of available coal, quantity and quality of water, weather conditions, available building material and advisable site for the plant. The report was supplemented by photographs of the river, the site selected, the coal tipples, railroad and other general views.

The site is on the bank of the river near the railroad, and about one hundred yards from the tipple of one of the largest mines, so that coal could be taken in dumping cars directly from the tipple to the boiler room.

Work was started on the actual design of the plant Apr. 1, the men being required to draw eight hours a day, and three hours overtime two nights a week. Moreover, a time-clock system was used to record each man's time and the time on each drawing, and penalties were imposed for lateness and absence. Each man was given at least one building, one piping, and one electrical drawing, and also some specification work.

The time required to complete all the drawings and all specifications was 5673 hours, an average of 56.73 hours per drawing. This compares favorably with the time required in a consulting engineering office.

One hundred drawings were made, checked and the specifications written for building construction, all equipment, piping, wiring, etc. Excellent coöperation was secured from the manufacturers of power-plant equipment, the design being considered as if a *bone fide* one, drawings, specifications and quotations being furnished in the usual manner. It was estimated that the plant as designed could furnish power at the switchboard for less than five mills per kilowatt-hour.

The plans call for the coal to be received in the coal house and either dumped into the crusher hopper or handled by a bucket crane. From the crusher the coal is taken on a belt conveyor to a bucket conveyor, which elevates it to the bunkers over the boilers.

The boilers selected were 800-hp. B. & W., set singly, with chain grates, the steam conditions being 190 lb. pressure and 130 deg. superheat. Seven boilers are specified with room for three more.

Three 5000-kw. horizontal turbo-generators operating at 6600 volts are specified for the turbine room, with room for one more; the turbines to be installed in units of two, with one open feed-water heater, two feed pumps, two turbo-circulating pumps, one motor-driven exciter, one turbine-driven exciter, and other minor equipment for each two turbines.

In the switch house and gallery are located the switchboard, and low-tension apparatus, office, toilet room and store room.

All high-tension (110,000-volt) transformers, switches, protective apparatus, etc., are located outside the building on a concrete foundation with steel framework.

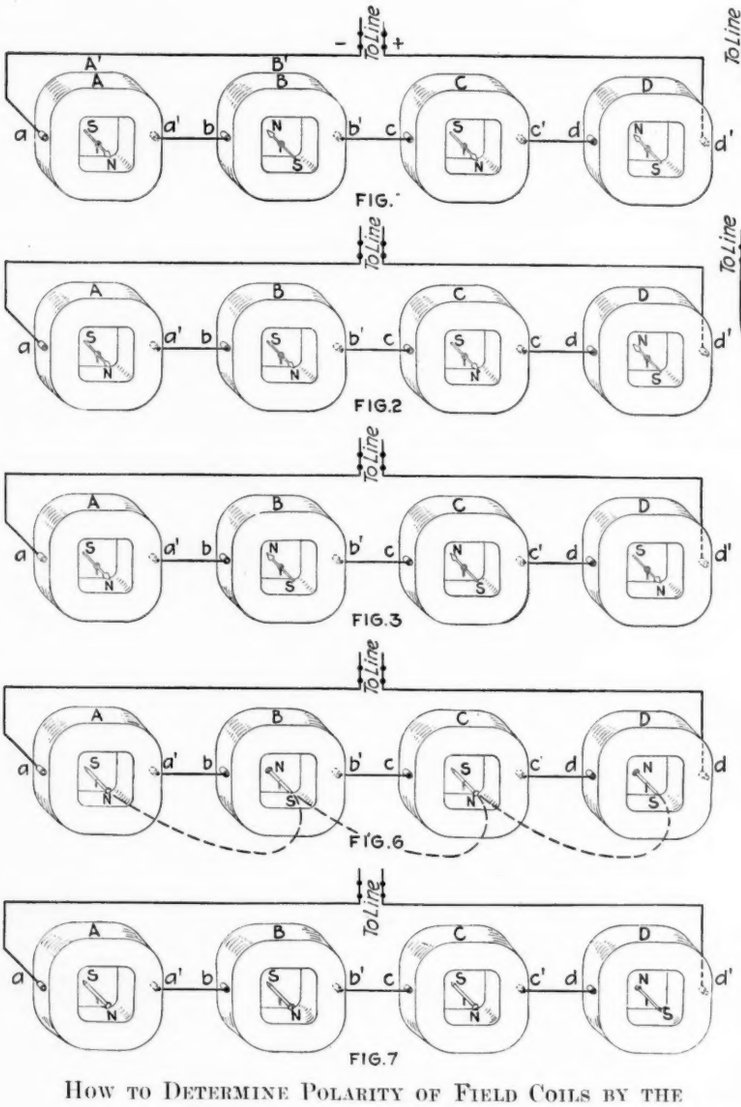
From the results obtained, it is thought that the combined thesis is of more benefit than the individual one. Although the principle of the individual thesis is sound, it is doubtful whether theses when conducted as in the past are of the greatest education and technical value. The time given to the undergraduate thesis is necessarily short, and in order to derive results that will appear to have some importance, the student usually takes a problem that is either too complex to be handled in the time available, or is too large for him to fully comprehend.

Testing Polarity of Field Coils

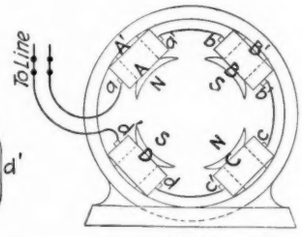
By F. A. Annett

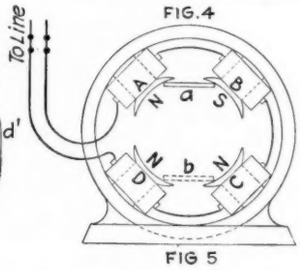
After the field coils have been taken out of a motor or generator for repairs or rewinding, unless they were carefully marked, the electrician is confronted with the problem of getting them back in the machine with the proper polarity. In many cases, the method of procedure is to first place the coils in the machine and connect them up temporarily; then test the pole-pieces for the proper polarity, but this is accompanied usually with considerable labor, for if the electrician is unfortunate enough to have a number of the coils of the wrong polarity, considerable unnecessary labor is involved in removing and reversing them.

A better method is to test the coils before they are placed in the machine, which may be done as follows: First, place the coils and connect them as in Fig. 1, then after closing the switch to the line, test the coils with a compass for the proper polarity. The compass should point alternately north and south in adjacent coils, as indicated in Fig. 1. If a condition is found like that shown in Fig. 2, where three adjacent coils are of the same polarity—that is, *A*, *B* and *C* are north poles, change coil *B* end for end or interchange the connections on it. This method means that coil *B* will have to be revolved through one-half revolution to bring the coil terminals in the proper position to make the connections.



How to Determine Polarity of Field Coils by the Use of a Compass or a Nail





Again, consider a condition as that in Fig. 3, where coils *A* and *B*, *C* and *D* are alternate north and south poles, but adjacent coils *A* and *D* are north poles and coils *B* and *C* are south poles. To remedy this condition, it will be necessary to change coils *C* and *D* end for end or interchange the connections on them to bring the four poles into the proper polarity. After the desired condition has been obtained, the coils may be placed on the polepieces just as they are located, as indicated in Figs. 1 and 4. After the coils have been located on the polepieces, they may again be tested with a compass to see if the work has been done properly.

When testing for polarity with a compass, care should be taken to always so hold it that the needle is free to move, for if the compass is shifted from one polepiece of opposite polarity, if the needle is not free to move, the polarity of the needle will be reversed and will indicate that the fields are of the same polarity; this might lead one into considerable trouble. A good plan is to make the test two or three times so that the chances of making a mistake will be reduced to a minimum.

Another convenient way to test the polepieces for the proper polarity is with a piece of iron, long enough to reach from one polepiece to another and placed as shown at *a* in Fig. 5. When the poles are alternately north and south, as at *a*, the iron will be strongly attracted; if both polepieces are of the same polarity, as at *b*, the attraction for the piece of iron will be very weak and it will be repelled when brought close to the polepieces. Care should be taken not to mistake the weak attraction which two like poles have for a piece of iron when brought in contact with them, for the strong pull two unlike poles will exert on the same piece of iron.

A good plan is to try the pull between any two poles, and if it is not very strong, interchange the connections on one coil. If the pull is increased the polarity is cor-

rect, and if decreased, the polarity is wrong and the coil leads that were interchanged should be changed back.

When a compass is not at hand for making the test as described in Fig. 1, a wire nail may be used for the purpose as indicated in Fig. 6. After the coils have been energized, if the nail is placed in one of them it will be magnetized and retain enough of the magnetism to act as a compass needle.

Care should be taken in using it as the magnetism will be easily reversed in it. Furthermore, it should be moved from one coil to another in the curved line as indicated by the dotted lines in Fig. 6. If the coils are of the proper polarity, the nail will point in the opposite direction in adjacent coils. If two adjacent poles are of the same polarity, the nail will point in the same direction as shown in Fig. 7, which can be corrected as in Fig. 2.

Operating Underfeed Stokers

By J. C. Hawkins

SYNOPSIS—The formation of clinker at the side walls and extending nearly halfway across the furnace, a serious trouble. Oyster shells prevent the clinker from fusing with the firebrick. Clinkers of New River slack less troublesome than clinkers from Georges Creek slack. Banked fires sometimes cause wind box and tuyere plates to warp.

In the operation of an underfeed-type stoker plant during the past four years the writer has experienced many difficulties. Some have been easily overcome, and others made less troublesome by experimenting with different methods of operation. One of the greatest troubles has been with clinker sticking to the side walls of the furnace. The stoker used is supposed to be self-cleaning, by pushing the clinker down onto the dump plate, and in a measure it performs this work successfully. All the coal used in this plant is bought on the B.t.u. basis, and one year the contract called for Georges Creek mine-run coal. This was usually of a good quality but it formed a clinker that adhered to the side walls of the furnace, and would sometimes extend nearly a third of the way across the furnace, and when the load was extra heavy would bridge entirely across to the center tuyeres; there being three tuyeres in each furnace, this clinker would be from 8 to 14 in. thick. When properly operated the stokers make no smoke even when forced, except when working the fire, either barring or cleaning, at which time they will smoke, and, on account of the rigid smoke laws it is necessary to clean the fires after dark and before daylight, twice during the 24 hr. being sufficient.

Cleaning the Stoker Fire

To do this the fire is burned down as low as the condition of the load will permit, and the clinkers ripped off the tuyere plates and pushed down onto the dump plate. When using Georges Creek coal the only way to get these clinkers off is with a 12-ft., 1¼-in. steel bar having a chisel point, the bar being driven with a 12-lb. sledge hammer. This heavy pounding loosened the side walls which soon had to be rebuilt. A better grade of firebrick was used, but did not stop the trouble. Next, oyster shells, which are very cheap here, were used to prevent the clinkers from sticking to the walls. After the fires were cleaned about three or four scoopfuls of the shells were thrown next to the wall on each side of the furnace. The idea was that the lime in the shells would form a flux which would prevent the clinker from sticking. This did much good in keeping the clinkers from sticking, and seemed to make them more brittle. The next year New River mine-run coal was used and did not give as much trouble in sticking to the walls as did the Georges Creek coal. Sometimes slack was sent in place of mine-run, at such times the clinker was exceptionally bad, although with New River slack oyster shells were not needed in such quantities as with Georges Creek slack.

In addition to the chisel bar the tools most useful are a 11-ft. slice bar for ripping up soft clinkers and breaking up the fire bed, an 11-ft. hoe for pushing the loose clinkers down onto the dump plate, a long hook to pull out the clinkers that form on the center tuyeres, the hook being used from the side door. Another handy tool is a 10-lb. sledge hammer with a 11-ft. iron handle. Sometimes the side-wall clinkers may be allowed to become cool at which time they can be broken off with the long-handled hammer. This method of getting the clinkers off injures the walls, but they must be got off some way, and experience has shown this way to be the best. In cleaning the fires, after the dirt and clinkers are pushed back onto the dead plate, they are allowed to lie there an hour or two. This gives the coke that may be pushed along with the clinkers a chance to burn, thereby preventing it from being dumped into the ashpit.

Several kinds of bituminous and semibituminous coals have been tried, all of which gave some trouble by clinkers sticking to the side walls. The New River crushed mine-run seems to clinker less than any coal tried in our plant.

Some kind of a water back could be used in place of the firebrick side walls. Such a water back would have to be connected to the boiler, and would not be very long lived as the temperature at this point is extremely high, but it would prevent the clinker from sticking, and would increase the capacity of the boiler to some extent.

Clinker Destroys Walls

Several kinds of firebrick have been used with the hope of getting one that the clinkers will not stick to; even a cement wall was tried. This wall was made of cement, sand and gravel. It did not last long as it cracked and broke away in pieces, and the clinkers seemed to stick to it as badly as to the firebrick walls.

Another difficulty was to get the right proportion of air and coal. The stokers are driven by the fan engine through a chain drive. When the steam pressure is up to standard the fan and stoker run very slowly. Then when the pressure drops one or two pounds the engine speeds up giving a greater air pressure, and pushing the coal faster. The speed is controlled by the damper regu-

lator. Several changes in the shaft gears were made before a speed was found that would give the best speed of the stoker in proportion to the fan speed. If the stoker ran too fast when the load was light, and the engine was running slow, the furnace would become full of green coal. If it ran too slow the fire would be too light, and when the fan did speed up an excess of cold air would be forced through the thin fire on the tuyeres carrying a great deal of heat to the stack. The best method of controlling the speed of the fan engine is to have it run at a constant speed to be determined by the conditions of the load. That is, a light load would require a slow constant speed, and a heavy load a higher constant speed. We tried setting the governor to give the desired speed so that the engine would run constant, the damper regulator being set to operate only in an emergency, and while the coal consumption was lowered, it was necessary to change the speed every time the load changed. This the firemen would not do as long as steam pressure was up and consequently in times of light load far too much air was used so that one saving was offset by another waste. If all the firemen could be trained to change the speed with changes of load, this plan would work all right. Eventually some system will be devised whereby the control will be automatic and at a constant speed as required to maintain the pressure.

One improvement that proved to be valuable was in taking the air for combustion from over the tops of the boilers. This increased the air for combustion about 90 deg. F., and also gave better ventilation to the room. This was done by building a wall around the fan open only to the space over the boilers, and having suitable doors to make all parts of the fan and engine accessible.

Coal Got Into Air Duct

Another trouble was with the wind box which became warped and cracked. Green, partly burned coal got through the cracks and through a broken tuyere plate into the air duct. This duct was galvanized iron leading from the air tunnel to each separate stoker, and the hot coal that got into the duct continued to burn, causing it to get red hot. The only way to get it out was to stop the fan, get into the tunnel through a manhole, crawl along to the branch, scoop up the fire and bring it out through the manhole. It took a very careful examination to find out how the coal got into the air duct, but it was learned that the warped and cracked wind box was caused by leaving the fire banked several days. In fact, more damage was done to the furnace the first year by banking fires than in the other three years put together, because the firemen were not familiar with the type of stoker. We find it possible to bank the fire for a day, but if left longer than that serious warping is likely to result.

To bank the fire it first should be cleaned, then close the damper in the air duct, and let the stoker run until a large amount of coal is pumped into the furnace. Next throw out the clutch, and partly close the stack damper. If the fire is to be kept banked for more than one day more coal must be pushed in to keep the fire from burning down to the tuyere plates and wind box, which are of cast iron, and if the fire reaches them they will become red hot, and either warp or crack, allowing green and partly burned coal to get into the wind box, also the tuyere plates will not fit tightly.

The air pressure in the wind box is regulated to suit the demand for steam. In cold weather when the load is heavy the speed of the fan engine is set by adjusting the governor to give a maximum air pressure of 2½ in. of water in the wind box. During this time the load sometimes reaches 200 per cent. of the rated capacity for a few hours. During the summer when the load is light and steady the maximum air pressure is set at 1½ in. of water.

Putting the Fire Out Quickly

In all boiler plants there are times in emergency when it is necessary to get the fire out as quickly as possible. For instance, in case of a broken handhole plate or burst tube, or low water. These furnaces when in full-load operation contain about a yard and a half of coal and fire, the fire, of course, being on top. In a case of this kind it is best to open the dump plate, close the air blast but leave the stack damper open, then turn the water hose on the fire, and push it into the ashpit with the hoe where it may be quenched. In one instance a hand chemical fire extinguisher was used with good results instead of water. In using water on the fire, care should be taken to keep it off the firebricks as it will make them crack. It is not good practice to turn water into the fire, but when a large quantity of fire must be got rid of as quickly as possible, drastic measures must be resorted to. If it is only necessary to put the fire out for a short time as in case of broken tube cap or low water, a little of the fire may remain without damage. After the cap is replaced and the boiler filled, the fire can be quickly started by turning on the blast and starting the stoker. A new fire may be built in much less time than is good for the boiler. The easiest way is to clean out all clinkers, pieces of brick, etc., after repairing. Then pump up a good head of coal, generally about two hoppers full. Next throw in a few pieces of wood, barrel staves, boxes, etc., piling them close to the front doors. Then put greasy waste under the wood in the doorway and set it on fire. The damper and front doors should be left open for a few minutes but the air blast left closed until the wood is burning well, then open the air blast a little, close the door and start the stoker. The fire may then be forced as fast as desired.

The underfeed type of stoker gives such an intense heat when being forced with a high air pressure that if used under a water-tube boiler especial care must be taken to keep the tubes clean and free from scale. If this is not done the tubes will be bagged very quickly. In handling these furnaces the firemen hardly realize the difference between a 50 per cent. load and a 150 per cent. load unless they shovel the coal into the hoppers by hand, but unless properly handled the stokers will waste as much coal as when firing by hand. This is usually due to excess air, and dumping good fire with the clinkers.

In this plant the smoke problem even when running at 200 per cent. overload has given little trouble but our neighbors are complaining of the fine ashes that are blown out of the stack when high forced draft is used. This trouble is, of course, much worse than it would be if only natural draft was used, and does give the white granite buildings a dirty appearance. This may be stopped in at least two ways. One is to place a series of closely set V-shaped baffles in a large chamber between the boiler and the stack, or by using a water curtain or cinder arrester.

Lagonda Fire-Tube Boiler-Turbine Cleaner

In Fig. 1 is shown a new air- or steam-turbine-driven vibrator knocker head for dislodging scale from the outer surfaces of return-tubular boiler tubes. At the same time, the soct from the inner surfaces which is loosened by the knocker, is blown out of the tube ahead of the cleaner by the exhaust from the turbine.

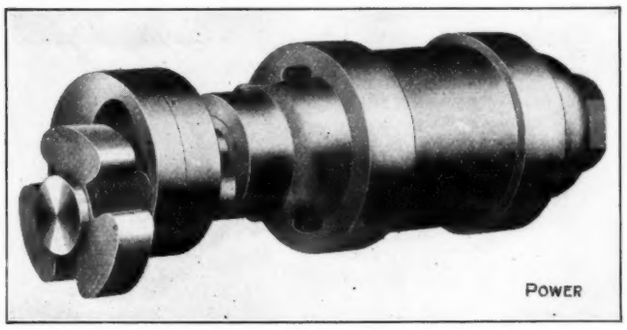


FIG. 1. NEW TURBINE-DRIVEN VIBRATOR HEAD

The head, also shown in Fig. 2, has a cylindrical body, somewhat smaller in diameter than the boiler tube, and an eccentrically pivoted lever carrying a clover-shaped knocker on a stud at its free end. The lever fits flush into a triangular recess in the forward face of the main body, the free end swinging in an arc through the center of the head.

The three hammer faces of the knocker are shaped to fit the inner circumference of the boiler tube to give a large area of contact.

As the head is driven at a high speed, the eccentrically pivoted lever carrying the knocker is thrown from side to side and the knocker is caused to revolve on its axis at each contact with the tube, giving a resultant whirling motion to the knocker and causing it to hit all of the tube. The cleaner, made by the Lagonda Manufacturing Co., Springfield, Ohio, is fed into the tube by a flexible rubber hose.

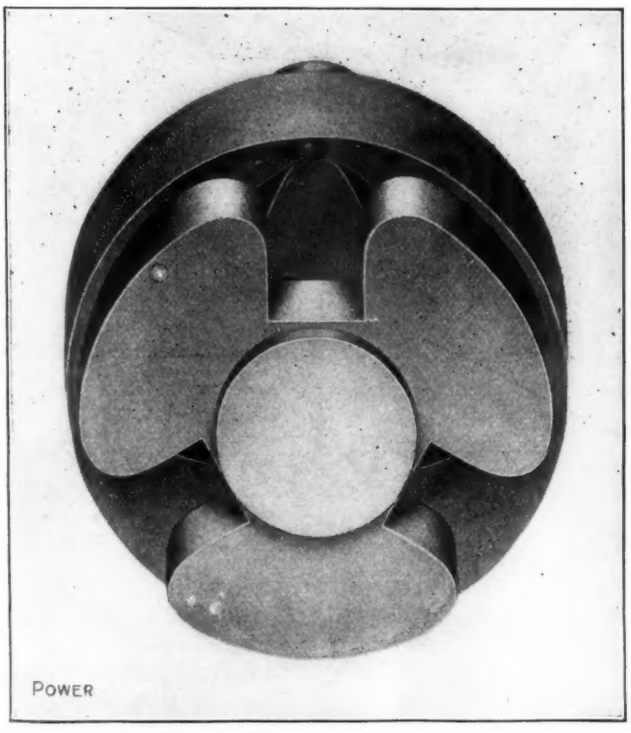


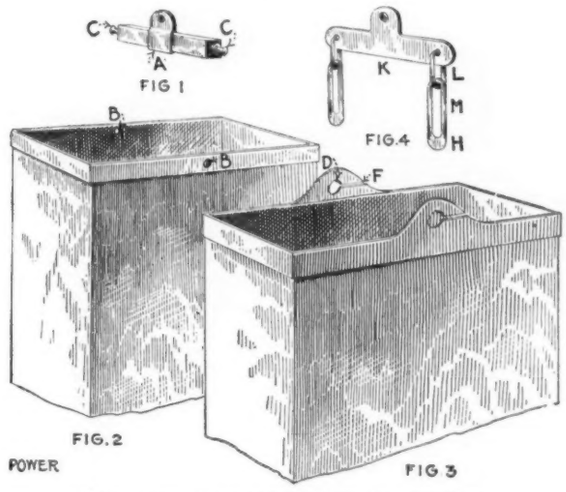
FIG. 2. END VIEW OF KNOCKER HEAD

The motor for driving the head is of the rotary-engine type. Air or steam, striking radial paddles, revolves the shaft and holds out the paddles to form a tight fit with the casing. There are four paddles, two of which are always under pressure.

Suggested Improvement for Lifting Ice Cans

BY ROBERT GRANDON

There has been but little improvement made during the past few years in the method of engaging ice cans to lift them from the brine bath. The method generally



OLD AND PROPOSED ARRANGEMENTS FOR LIFTING ICE CANS

used, that of the spring can dog *A*, Fig. 1, engaging the holes *B*, Fig. 2, in the sides of the can, is crude; it has caused many ammonia leaks and been the means of injuring the foot of the ice puller. The small shoulders *C*, Fig. 1, soon wear off, so that if the can spreads or there is a little carelessness by the ice puller, the can and ice drop. Should the can with its ice go back into the brine bath, it will probably strike a coil and start an ammonia leak; should the puller be lowering the can into the dump, his foot is mashed or his leg bruised.

In an effort to start something in the way of an improvement, the writer offers a suggestion. It would increase the first cost of the can, but pay in the long run, if it should stop the dropping of the cans.

In Fig. 3, the bond in the can is made with a hook arrangement, shown at *D*; the slot *F* slopes downward slightly from the hole at the center. In Fig. 4, the single tree *K* has small chain links *L* at the ends and in these are the engaging links *M*, which have the lower end *H* elongated (for wear) and flattened to pass through the slot at *F*. It would be necessary to make these links long and narrow, as shown in the sketch, and of about $\frac{5}{16}$-in. iron to hook on the can when in the brine bath. It might be necessary to trim the woodwork a trifle to make room for the link to pass. In any event, the result obtained would be worth the trouble and expense.

Deformation of Welded Drums

By J. E. Terman

Many readers will remember a paper of much interest by S. H. Barraclough and A. J. Gibson, on the stresses in unsymmetrical boiler joints, an abstract of which was published in Power of Apr. 15, 1913. Mr. Barraclough, in conjunction with H. A. Rorke, has made similar experiments on autogenously welded drums or barrels used for transporting sulphuric acid and read a paper on the results of these tests before the Engineering Association of New South Wales, an abstract of which follows:

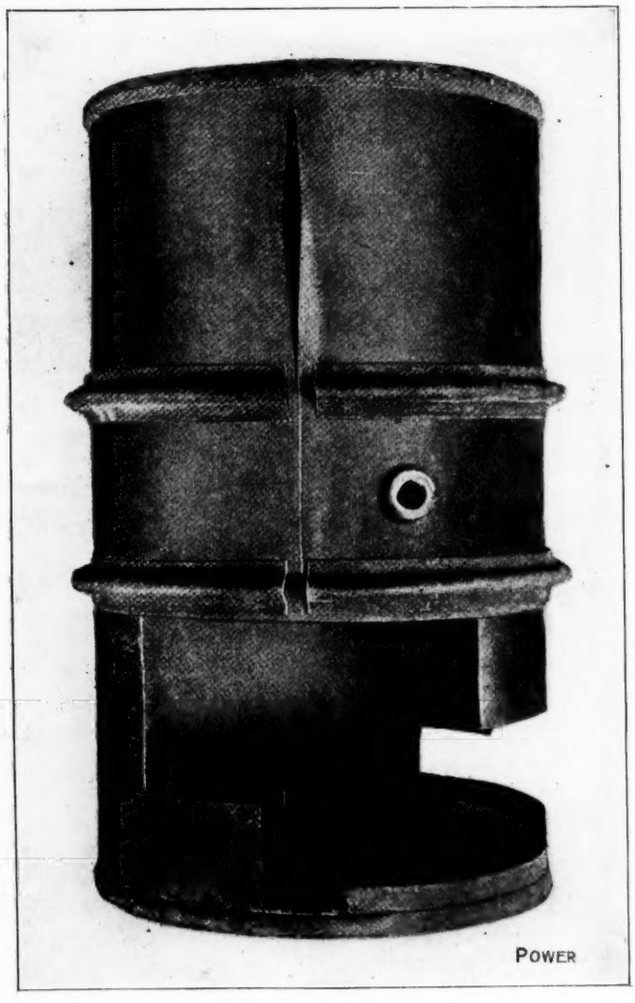


Fig. 1. Drum *A*, Showing Failure of Longitudinal Weld

The drums were of thin steel plate, about $\frac{1}{10}$ in. thick; the general construction is shown in Fig. 1. This drum failed while being handled on a dock, evidently the result of an accumulation of pressure of gas resulting from the action of the acid on the material of the drum. A man was killed as a result of this accident.

These drums were formed by welding the parts with an oxyacetylene flame, the welds being made without any special preparation of the joined edges, except to shear them straight and butt the edges together; no other material was added as is customary in welding very thin plates. It will be noted that there are two bands or hoops around the drums, these being formed separately and welded to the shell as well as together at the ends after passing around the drum.

In order to determine the general efficiency of welds made by the oxyacetylene process, a specimen of plate

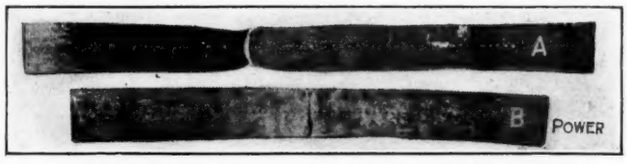


Fig. 2. *A*, Unwelded Test Piece; *B*, Welded Test Piece

about 2 in. wide and ½ in. thick was carefully welded and tested, as was also a piece of the solid plate from the same sample. These test pieces are shown (Fig. 2) as they appeared after being broken, *A* and *B* representing respectively the solid specimen and the one which was welded. The results of the tests are given graphically in Fig. 3, where the letters on the curves correspond to those given on the test pieces in Fig. 2. This test proved that the total elongation in the case of the solid plate was 33.7 per cent. against 5 per cent. for the welded specimen, the ultimate strength of the solid plate was about 57,000 lb. against 48,000 lb. for the welded plate. It will be noted from Fig. 3 that the behavior of both specimens was about the same, within the elastic limit. These results show a percentage of strength for the welded joint of about 77 per cent. The authors point out that claims are often made that the strength of autogenously welded joints is greater than that of the solid plate, but in their experience such claims are without foundation. Where results are obtained which indicate that the weld is stronger

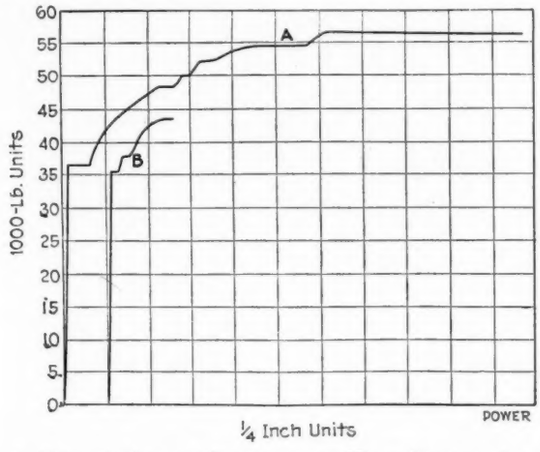


Fig. 3. Stress-Strain Diagram of Test Pieces *A* and *B*

than the solid plate, it is probably due to the metal being piled up at the weld so that its thickness at the joint is greater than in the solid plate.

Reference was made to a series of tests of oxyacetylene welds made at the University of Illinois by H. L. Whittemore and reported in bulletin No. 45 of the university, where it is shown that in the test of eleven such welds the percentage of efficiency ran from 64.4 to 86.6 per cent.,

from which it was concluded that the maximum efficiency that could be expected for such welds was 85 per cent.

The drum shown in Fig. 1 failed through the longitudinal seam, the rupture occurring near the top end. The hoops have been cut away at the joint so that the entire length of the welded seam can be seen. Since the tensile strength of the shell was about 57,000 lb. per sq.in., it was estimated that the bursting pressure, without considering the effect of the hoops or heads, would be about 450 lb. for the solid plate; and allowing an efficiency of 50 per cent. for the welded joint and a factor of safety of five, the safe working pressure would be about 45 lb. The manufacturers of these vessels placed a test pressure on them of 60 lb., and the authors considered this about right. Measurement of the strains on the surfaces of such drums as will be described presently showed that the usual methods for calculating the strength of structures of this kind are incorrect.

Destructive tests made on a number of drums constructed like the one which exploded, showed that when a pressure of about 85 lb. was reached the heads began to bulge, and at 100 lb. both heads had reversed and became concave to pressure. The welded head seams started to leak at 105 lb. on practically all the drums tested, and while the longitudinal seam was the point which appeared to be the weakest part on the drum which failed, such seams were generally much stronger than the head seams. Six drums were examined in all, one of which was the drum causing the accident. Drum *F* of this lot, after having measurements made of the distortions on its surface due to the internal pressure, was submitted to a destructive pressure test. At 105 lb., when the head seam began to leak, the longitudinal seam was hammered to see how it would stand such abuse under pressure. Owing to some peculiarity in the construction of this drum, the

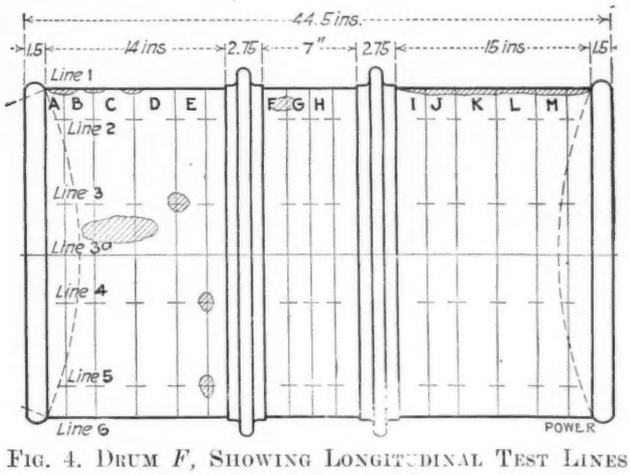


FIG. 4. DRUM *F*, SHOWING LONGITUDINAL TEST LINES 1 TO 6 AND CIRCUMFERENTIAL LINES *A* TO *M*. SHADED AREAS REPRESENT DENTS

shell along the longitudinal seam was in compression rather than in tension, and after several blows with a machinist hammer had started the seam to leak, a slight rise in the pressure applied would stop the leaks; this experiment was repeated a number of times with the same result. Several pressure tests were made on drums similar to drum *F*, but none of these indicated compressive stresses in the shell except in spots where the surfaces had been dented or otherwise deformed.

The final conclusions of the authors regarding the use of autogenous welds for the longitudinal seams of such vessels were that they should be able to withstand the strains of ordinary use. That the concave head bulged at a pressure considerably under the bursting strength of the cylindrical portion of the drum, seemed to indicate that this form of head was in the nature of a safety valve, and by increasing the capacity of the drum in the act of

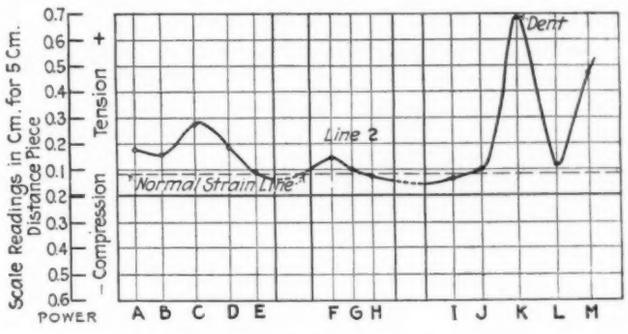


FIG. 5. STRAINS ALONG LINE 2

reversing, it would make the vessel safe from explosion for a longer time than a head of more rigid construction.

While it was believed from the results of the tests that the actual efficiency of the welds, where they extended entirely through the thickness of the sheets, was something like 80 per cent., it was found that practically none of the joints was thus perfectly welded and, owing to this fact, it was considered safe to allow an efficiency only of 25 per cent. for such joints. With these values for the efficiency of joint and with an actual factor of safety of 5, the factor of safety to be applied in reference to the strength of the solid plate would be 20, which was considered by the authors to be about the right figure when the risk to life was considered.

In order to estimate the stresses in the different parts of a drum while under pressure, the semi-circumference of drum *F* was divided into six equal parts by longitudinal lines 1 to 6, as in Fig. 4. Line 1 is along the welded joint and there is also an extra line, 3a, placed on the center diameter. In addition to the longitudinal lines, circumferential lines *A* to *M* were drawn as shown. Measurements of the longitudinal and circumferential deformations of the shell when under an internal pressure of 30 lb. were made at each of the intersections of the lines just mentioned. Fig. 5 gives the results obtained in a longitudinal direction along line 2 in Fig. 4. It will be noted that, while all the plate is in tension along this line, the deformations are by no means regular and that they are tremendously increased by a dent on line *K*.

In Fig. 6, the circumferential deformations as found under 30 lb. pressure are plotted on each side of the vertical diameter, although the results plotted on this figure apply to the measurements on one side of the drum *F*, along the lines *A*, *C*, *D* and *E*, in Fig. 4. The deformations over the surfaces of the drums were measured by means of Martens extensometers, the distance pieces of which were about 2 in. long. In making the measurements, the pressure was raised from 0 to 30 lb. and then lowered again to zero, readings being taken at each 5-lb. change of pressure, both while the pressure was being raised and lowered. The values given in Figs. 5 and 6 represent only the readings taken at 30 lb. pressure. In Fig. 6 these values are plotted without reference to whether a tensile or a compressive stress existed at the

point measured, but it is stated that the high values along the upper part of the vertical diameter in Fig. 6, which represents the location of the welded seam, are compressions and not extensions, as would be naturally expected.

While Figs. 5 and 6 give the longitudinal strains, only at right angles to each other, there are, of course, strains in all other directions and their values must lie between the two just given. In order to determine the value of the strains around a point on the shell, the distance piece of the extensometer was moved around a fixed point on the shell until it had occupied 12 positions equal distances apart around this point, measurements being taken at each point during the raising and lowering of the pressure, as was the case for the longitudinal and circumferential strains.

Fig. 7 shows the results of such measurements made at the point produced by the intersection of lines *G* and 6, as given in Fig. 4; it will be noted that this intersection is diametrically opposite the welded seam. That the extensions measured circumferentially are not twice those measured longitudinally, as might be expected, is because the strains in one direction produce contractions at right angles to them. Therefore, the high circumferential stresses produce high longitudinal strains of the opposite sign to these produced by the longitudinal stresses and *vice versa* for the circumferential strains produced by the longitudinal stresses. This explains why the curve in Fig. 7 is dumb-bell shape and not elliptical. With Poissons' ratio taken at ¼ (this ratio expressing the relation between the extensions in the direction of a stress as compared with those in a transverse direction) the longitudinal extensions would be to the circumferential extensions as 1 to 3½, and it will be noted that this is about true in the case of Fig. 7.

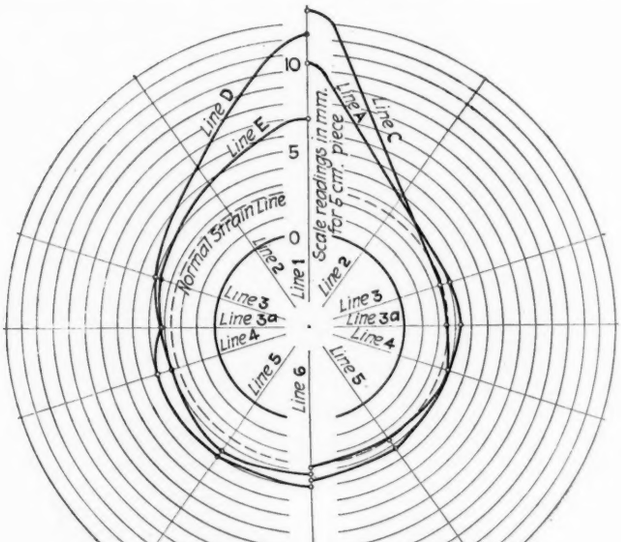


FIG. 6. CURVES OF CIRCUMFERENTIAL STRAINS ON LINES *A, C, D* AND *E*

DISCUSSION

A member, referring to the safety-valve action of the concave heads, said that it would seem possible to better provide additional capacity in such drums after pressure began to accumulate, by corrugating the heads rather than bumping them. Such heads could give in, responding to an increase in pressure without so severely straining the material as would be the case with the convex form of head.

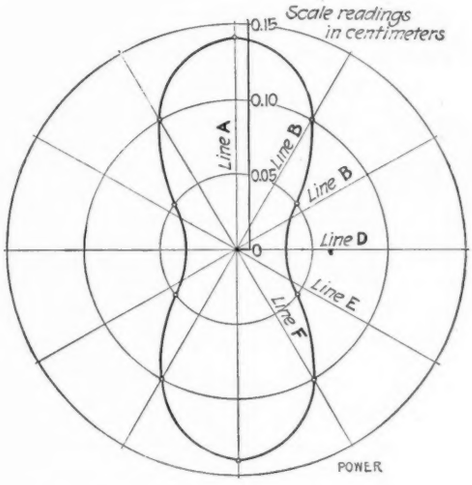


FIG. 7. POLAR DIAGRAM OF STRAINS

It was suggested that such drums for the transportation of sulphuric acid, or for other uses where the contents might produce chemical action during transit which might cause a dangerous internal pressure, could be examined from time to time as might be found necessary, the bulging of the heads giving warning of the approach of danger. This method is said to be in use to determine if canned goods are sound, all cans with bulged ends being thrown out by the inspector as unfit for use. This member also took up the question of the improvement of welds by hammering while hot. Mr. Barraclough, in his concluding remarks, said that all such welds could be improved by hammering in the process of manufacture.

Professor Groth was quoted as stating, in a book on autogenous welding, that no one should be allowed to weld a part subject to stress until he had acquired at least two years' experience in doing such work under a competent operator. This statement is about in line with the avowed desire of the better firms doing autogenous welding in the United States; namely, to have operators for such work licensed.

The president said that as the stresses appeared to be so high at the welded joint, Fig. 6, this would require much investigation. He suggested that these figures were arrived at by assuming uniform strength for the material at all points of the drum, and that this might lead to erroneous conclusions unless other factors were considered besides the elasticity of the material. It seems improbable that the actual stresses due to internal pressure in the drum could be materially different at the seams and at other parts of the drum, unless the drum happened to be deformed at the seam so as to produce such a result.

The authors said that arrangements were being made to repeat these experiments on drums of simpler design, so as to make less complicated the comparison of results obtained with those which should be theoretically expected.

Return-Tubular Boiler Furnace Development*

By Osborn Monnett†

SYNOPSIS—The evolution of a furnace suitable for high-volatile coals from the McGinnis, Gulickson and firebrick-inclosed furnaces.

After using steam jets, the next step in the attempt to keep down smoke in the furnace of a tubular boiler was to build an arch over the combustion chamber back of the bridge-wall, somewhat as shown in Fig. 1. In con-

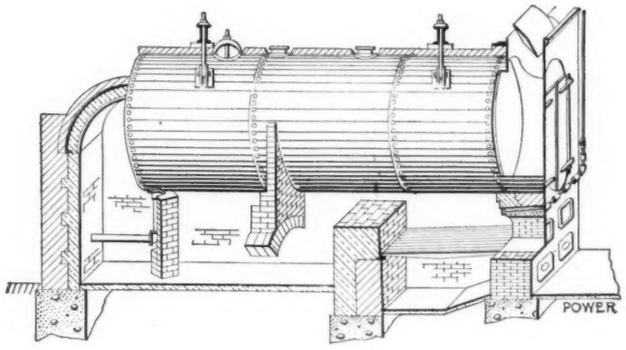


Fig. 1. Return-Tubular with Single-Span Deflection Arch

nection with the steam jets the arch was an improvement as it broke up the gases and mixed them to a certain extent. However, this design lacked several essential features of a successful furnace, the principal objection be-

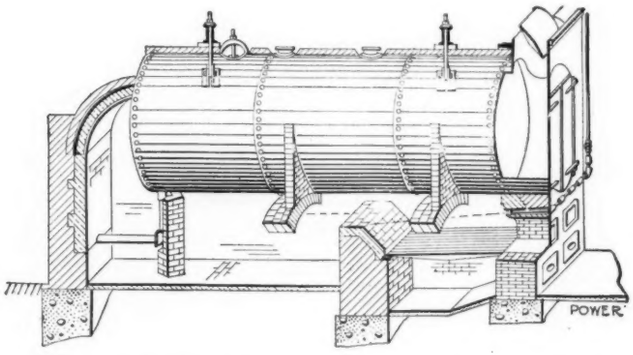


Fig. 2. McGinnis Arches in Front and Back of Bridge-Wall

ing that it did not provide sufficient temperature at the point of mixture. The heat absorption into the boiler was sufficient to reduce the gas temperature to such an extent as to impair combustion of the volatile matter.

An elaboration of this design was the old so called McGinnis arch setting, which was in quite common use 15 years ago. This consisted of two arches, one back of the bridge-wall and another over the grates in front of the bridge-wall, as in Fig. 2. This was an improvement over the former setting, because the gases were mixed more thoroughly and the setting gave good service until smoke began to be read more closely. A peculiarity of the setting is that the gases passing under the front arch must make one turn upward over the bridge-wall, another turn along the shell and then come in contact with the back arch, where another change in direction occurs. This will be apparent from an inspection of Fig. 2. Given careful attention, with a judicious use of the steam jets, this setting, while not considered in any sense modern, will give fairly good results. The same objection as to temperature of gases exists and detracts from its efficiency.

Another setting popular in the Middle West from 1885 to 1907 was the Gulickson, shown in Fig. 3. This consisted of a double arch over the bridge-wall with another single-span arch back of the bridge-wall. This construction split up the gases as they passed over the bridge-wall and to some extent mixed them at the second arch. Modifications of the above designs were made without number in an attempt to satisfy the public in the matter of smoke suppression. These attempts embraced various designs of so called pigeonhole bridge-walls, wing

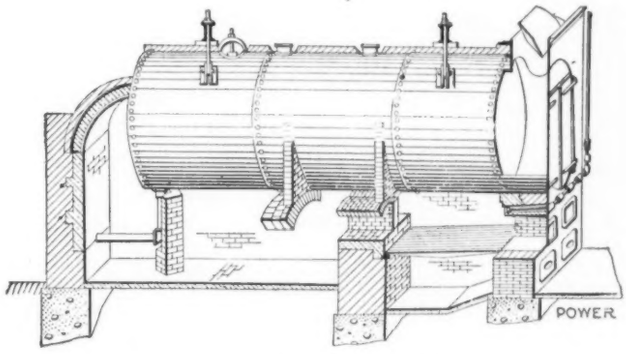


Fig. 3. The Gulickson Setting

walls, piers, perforated drop arches, bulkheads, etc., but in nearly every case one or more of the essential features of a successful furnace were missing. All of the above settings were in use up to about 1907, when the subject was taken up seriously in Chicago by the Department of Smoke Inspection as at present organized.

Firebrick-Inclosed Furnaces

The best authorities at this time advised surrounding the fire by brickwork and thus maintain a high temperature to increase the ignition and provide a long-flame travel during which combustion could be made complete before the gases came into contact with the heating surface. A number of firebrick-inclosed furnaces of the dutch-oven type were built, some full extension and some half extension, but the majority were flush front, as shown in Fig. 4. At first they were built without and later with a slight drop arch behind the bridge-wall. These settings were not satisfactory, but furnished the information which led to the present ideas on hand-fired furnaces. With these dutch-oven settings the initial expense was high and a great deal of the heating surface

*Copyrighted, 1914, Osborn Monnett.
†Smoke inspector, city of Chicago.

in the shell was covered up, with consequent loss of capacity and efficiency, and the settings proved to be difficult to run without dense smoke. It soon developed that mere flame travel in hand-fired furnaces was not sufficient to produce good combustion. It was shown that even where the path of the gases from the grates to the heating surface was excessive, if there were not in this path some form of mixing arrangement that would abruptly change the direction of the gases and bring them into intimate contact, a stratification would take place and smoke would be made. The deflection arches as then built were high and accomplished imperfectly the result sought. They were afterward built lower and lower to get more positive mixture, but still there was smoke.

The radiating effect from an intensely hot arch over the fire distilled the volatile matter from the fuel more rapidly than it could be mixed with air and consumed in the furnace. In fact, the furnace had a "muffle oven" effect and puffs of dense smoke were made in spite of the greatest care in operation. Finally, when it became evident that the furnace was not adapted to high-volatile coals, the arches over the fire were removed to reduce the temperature of ignition with a consequent reduction in the rapidity of distillation of the volatile matter. This resulted in a construction similar to that shown in Fig. 5, which is known as the Department No. 4 furnace, consisting of an arch sprung over the bridge-wall and extending back some 3 ft., with a deflection arch to mix the gases. This furnace increased the heat absorption into the boiler by direct radiation from the fire; decreased the rapidity of distillation of the volatile matter by reducing the igniting effect and resulted in a furnace much easier to run without smoke. A few dutch-oven furnaces equipped with special air admission have survived. They

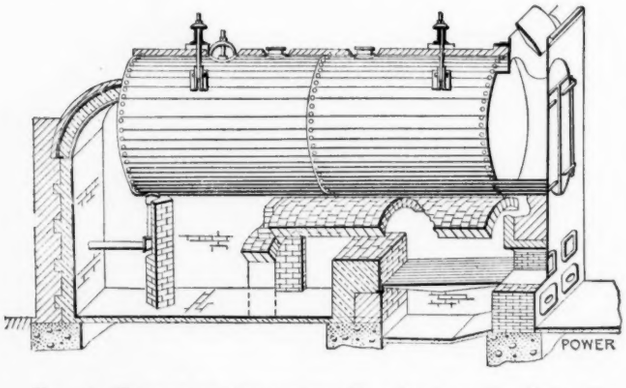


FIG. 4. FIREBRICK-INCLOSED FURNACE WITH SINGLE-SPAN DEFLECTION ARCH

generally burn a picked egg coal and with careful attention to the air supply have succeeded in running clean.

THEORY OF THE "COOL" FURNACE

Experiences with the No. 4 furnace and those that came after it gradually developed the theory upon which is founded the design of modern hand-fired furnaces as used by the Chicago Smoke Department for high-volatile coals. It became evident that ignition was not necessary to burn this kind of coal; draft was the main essential. As evidence of this, a locomotive with a plain firebox without a brick arch can burn with ease 100 lb. of coal per square foot of grate surface per hour without any ignition except that furnished by the fire itself, because the draft is adequate for the purpose.

In the next place, it was found that a "cool" furnace (one having direct radiation from the fire to the heating surface) not only increased efficiency and capacity by increasing heat absorption, but reduced the liability to dense smoke because the volume of volatile passing off was at no time in excess of the capacity of the furnace to

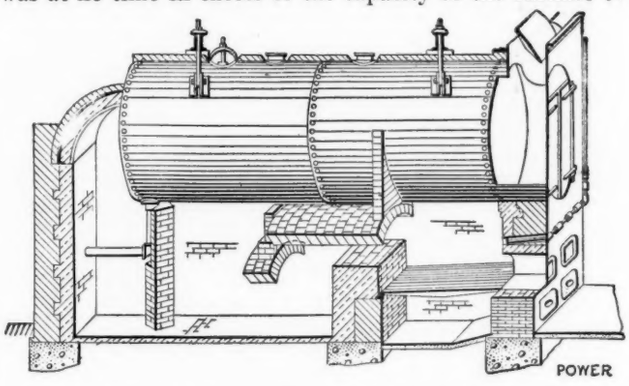


FIG. 5. SINGLE-ARCH BRIDGE-WALL FURNACE WITH SINGLE-SPAN DEFLECTION ARCH (NO. 4 FURNACE)

take care of it. All that was necessary then was to provide a zone of high temperature back of the bridge-wall which would maintain the gases at or above the igniting temperature; then provide a deflection arch against which the gases would impinge at this high temperature, and finally, provide air admission over the fire in sufficient quantity to mix in the high-temperature zone with the volatile gases and furnish the necessary oxygen for complete combustion. As from 30 to 35 per cent. of the weight of the fuel is in the form of volatile gases, the air necessary to form a proper mixture must be admitted over the fire. With the ordinary drafts encountered in stationary practice, it has been repeatedly demonstrated that it is impossible to draw sufficient air through the grates to completely burn the volatile matter. The term "excess air" ordinarily applied to air being admitted over the fire, is not in any sense in excess of the air required to burn the fuel, as it must be remembered that a large proportion of the fuel is in the escaping gases and it must have this air to be completely consumed.

Steam Pipes as Lightning Conductors—Calling attention to the splendid set of conductors for lightning protection that the steam pipes of a heating system afford the "Scientific American" suggests that they be made use of for this purpose. Under ordinary conditions the lightning cannot reach these pipes until it has punctured and probably set fire to the roof or sidewalls, and the writer declares that he has seen many buildings damaged in this way. It is, therefore, proposed that several pieces of pipe be extended up through the roof from the top floor radiators and capped at the ends.

Cost of Steam—In a report of the recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers we said that A. C. Rogers, superintendent of heating of the Toledo Ry. & Light Co., questioned a statement made by F. W. Ballard, chief engineer of the municipal electric-light plant at Cleveland at a previous meeting, that they were making 1000 lb. of steam for 10c., which would hardly pay the coal cost. Mr. Ballard explained that the 10c. per 1000 lb. of steam given in the discussion, to which exception is taken, is the value of the saving which would be made under certain conditions, this saving to be figured very conservatively. As a matter of fact, 10c. per 1000 lb. of steam is generally used in capitalization of saving, due to efficiency, when purchasing machinery, such as steam turbines, etc., as this is practically the value of the steam figure in cost of coal for its generation.

First Pacific-Built Diesel Ship

By C. A. Osier

The "Warrior," shown in Fig. 1, has the distinction of being the first Diesel engine ship to be built on the Pacific coast. Constructed at the yards of Nilson & Kelez of Seattle, for the cannery trade, it has a length of 87 ft., 17-ft. beam and 7-ft. draft, and is propelled by a four-cylinder, 120-horsepower, four-stroke-cycle, "Nlsco"* Diesel engine.

In addition to the main unit, there is a four-cylinder, 12-horsepower engine for driving the dynamo, auxiliary pumps and small compressor, and a 9-horsepower hoisting engine on the after deck. A steam-heating plant burning coal supplies steam for heating.

The two-stage compressor working on the forward end of the main shaft supplies the compressed air for spraying the fuel into the cylinders and for charging the starting air flasks. The small auxiliary compressor is for use in emergency only.

The air piping is of seamless copper tubing and the joints are not only screw threaded, but soldered to make them absolutely air-tight. The air-control valves are placed in a horizontal line across the after end of the engine, directly in front of the engineer's stand so that the entire system may be handled from that point. The small throttle valve is also located at this point and the four small globe valves which regulate the supply of fuel oil to the atomizers at each cylinder are within easy reach.

A flywheel governor is employed controlling the suction valve of the fuel pump. For running at reduced speed a hand control is employed. A balancing valve

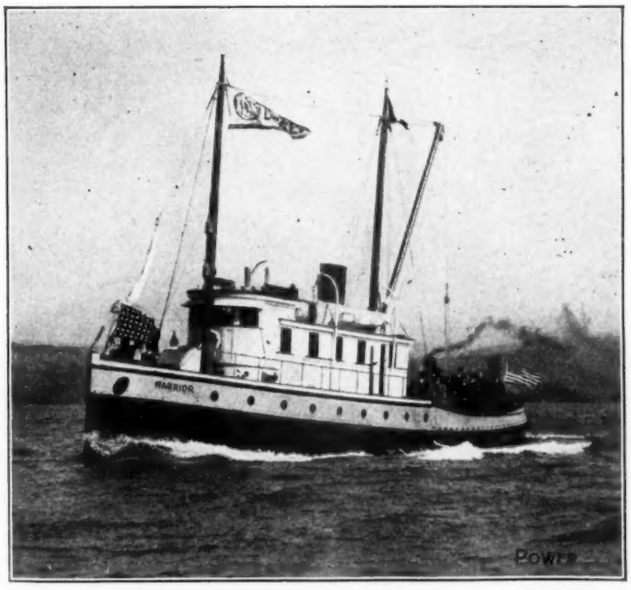


Fig. 1. "Warrior" on Trial Trip

keeps the oil at constant pressure and allows any excess to be drained back to the supply tank, which holds about seven gallons, and receives the oil from the main tanks through a small rotary pump, belt-driven from the main engine.

*Described in "Power," June 3, 1913.

The exhaust gases are led from the exhaust manifold along the upper port side of the engine and out through a well lagged exhaust pipe into the stack. Too much fuel oil fed to the cylinders quickly shows in a smoky exhaust, but the regulation of this oil till there is an al-

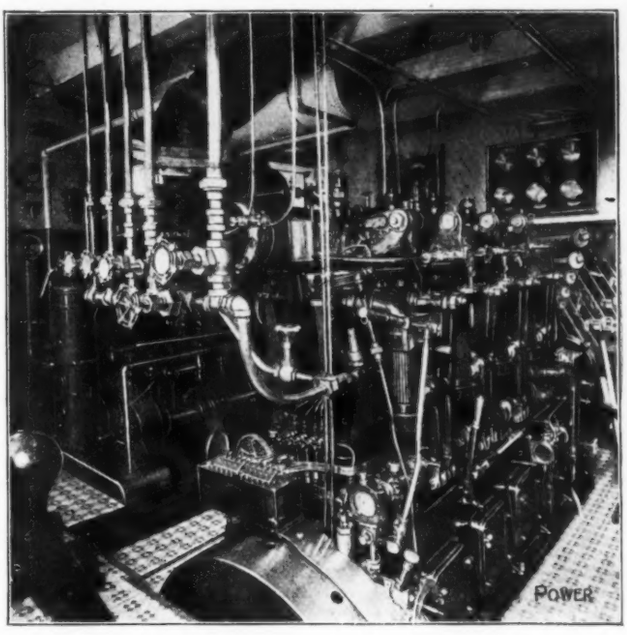


Fig. 2. Engine Room of "Warrior"

most imperceptible vapor from the stack has been found easy.

Lubrication of the engine is accomplished from two large Detroit lubricators, from several independent oil cups and from the usual grease cups, the latter being used principally on the camshaft bearings and rocker-arm pins. A very light gas-engine oil is used in the cylinders.

The lubricators are filled from bent copper piping coming up through the floor of the engine room, and supplied from a 65-gallon tank mounted above the lockers on the starboard side. This method of filling eliminates the usual slopping of oil when the tanks are replenished during rough weather. The circulating water for the engine is supplied by a centrifugal pump driven by the flywheel.

The most interesting part of the "Warrior's" performance, however, is contained in the record of her trial runs, showing the economy of the Diesel type of engine. The craft operates on Star fuel oil, and the tanks have a capacity of 1400 gallons. The price of Star oil in Seattle is 2¾ cents per gallon or $1.15 per barrel containing 42 gallons.

The trials showed a fuel consumption of 6¼ gallons per hour, which with the tanks filled will permit 224 hours' running. At a speed of 10.3 knots or 11.85 miles per hour, which was attained on the trial trip, the vessel will have a cruising radius of 2665 miles at a total cost of $38.50. This figures about 1¾ cents per mile—a most creditable showing.

Locomotive Smoke-Box Cinder as Fuel

SYNOPSIS—This cinder has a relatively high heat value, but, owing to the absence of volatile matter, it is difficult to ignite. Attempts have been made to burn it, mixed with coal in an ordinary furnace, but without much success. The Pluto stoker seems especially adapted to this fuel, as is shown by the test figures given.

The utilization of cinder from the smoke boxes of locomotives is a problem which has received much thought. This cinder has a heat value of between 6300 and 8100 B.t.u. per pound, and is mostly in the form of dust particles which have been drawn through the tubes by the strong draft and though subjected to combustion in the firebox have not been fully burned, but instead only coked. The stronger the draft and the higher the grate duty, the more are such particles carried through and the less are they burned.

The comparatively high heat value of the cinder prompts the desire to use it again under stationary boilers, although efforts to this end have in the past met with little success. Through lack of the volatile element it could not be ignited readily, and its limit of usefulness was thus narrowed to adding a part of it to the usual fuel. Even then it was found that a large part of the cinder appeared in the refuse from the furnace, inasmuch as such an addition to a volatile coal did not suffice to yield a temperature high enough for ignition. Doing so with natural draft is entirely out of the question; forced draft must be used.

The first successes in this line were attained with the forced-draft, closed-ashpit type of furnace, such as the Ludlicz and Kridlo designs. These, however, have the disadvantage that the firing, cleaning and removal of clinker must be done by hand, resulting in material losses due to frequently opening the doors; especially as the fire has to be almost unceasingly worked to maintain combustion, which, even with forced draft, is poor and much of the cinder is carried off as flue dust. Furthermore, to be able at all to burn this cinder, the dust part must be sifted out, thus utilizing only the more definitely granulated remainder and necessitating special appliances.

In efforts to burn this cinder mechanically without the admixture of a high-volatile coal, arches and different grates were tried, but they were unproductive of favorable results. At the most, only about 40 per cent. of the cinder could be burned in combination with coal.

Quite recently, exhaustive tests were made, using a forced-draft "Pluto" stoker, as that furnace had already shown success in the burning of fuel relatively low in volatile content, such as coke cinder, anthracite dust and the like. The main feature of this stoker is the back-and-forth moving hollow-grate bars, which serve as air ducts, the air being blown through the slots in the upper surfaces. As this air, in its passage through the hot, hollow bars is preheated, favorable combustion results without impairment of the ignition temperature through the influx of cold air.

*Translated and abstracted from an article by O. Nerger in "Zeitschrift des Vereines Deutscher Ingenieure."

However, it was seen in advance that this stoker, taken as it was, could not be used for the burning of locomotive cinder. Among other things, in spite of the opposed movements of adjacent grate bars, the cinder showed a tendency to bake fast and hinder the passage of the fuel across the grate. Furthermore, this baking impeded the free egress of air from the interior of the bars to the burning fuel and as a result the cinder could not be fully consumed. Better results were ultimately obtained through slight changes, the principal improvement being brought about by the introduction of steam into the hollow grate bars. The clinker did not attach itself to the bars, the passage of the fuel across the grate was better, a more rapid rate of combustion was attained and less combustible remained unconsumed.

It was thus demonstrated that firing with locomotive cinder, unmixed with coal, is not only possible with a "Pluto" stoker, but that it can be made to yield a comparatively good efficiency. The higher temperature required for ignition is accomplished in this case by means of a fire arch which diverts the flame back toward the front of the grate; this is installed close to the grate and at an angle to it. Therefore, the course of the flame is from back to front, exerting a radiating effect on the fuel entering on the grate, thus tending to produce ignition in the initial zone of the stoker area. The following data were obtained from a test on this stoker with locomotive smokebox cinder:

RESULTS OF TEST

Duration of test, hours	3
Type of boiler	Water tube
Heating surface, square feet	1345
Grate surface, square feet	63.6
Kind of fuel	Unsifted locomotive smokebox cinder
Heat value, B.t.u., per lb	7324
Fuel fired per hour, per sq.ft. of grate surface, lb.	19.5
Water evaporated per hr., per sq.ft. of heating surface, lb.	3.45
Water evaporated per hr., per sq.ft. of heating surface, from and at 212 deg., lb	4.29
Gage pressure, lb	145
Flue-gas temperature, at boiler, deg	590
Temperature of the air for combustion	68
Draft in inches of water:	
At the furnace	0.157
At the flue	0.354
Pressure in the grate bars	0.472
CO_2, per cent	9
CO, per cent	0
C, per cent	9.5
Evaporation per lb. of fuel:	
As tested	3.77
From and at 212 deg	4.65
Heat balance, per cent.:	
Available from the boiler	63.5
Lost in waste gases	20.4
Losses through radiation, unconsumed fuel, etc.	16.1

It will be seen from the foregoing results that quite a high grate duty can be obtained from locomotive smokebox cinder if it is properly burned. The CO_2 percentage of 9 permitted the maintenance of a favorable air excess. The flue temperature was relatively high, but that was a matter of boiler construction and the heat carried off by the waste gases could thus have been materially lessened by a more suitable design. The ash was well burned out and contained only traces of combustible matter.

In considering this form of fuel the following points must be regarded: Either a chain grate is to be decided on, using a definite part of cinder in combination with coal or there must be used a furnace especially adapted to the burning of cinder only. The installation

costs of a "Pluto" stoker are higher than of a chain grate, particularly as it requires forced draft.

For the case in hand, let it be supposed that 20,000,000 heat units per hour are being utilized for power purposes for 300 working days of 12 hr. each. The coal will be assumed as costing $1.67 per ton of 2000 lb. at the boiler house; the price for the locomotive cinder being placed by the railway management at about $0.65. The heat value of the coal is 10,800 B.t.u., and for the cinder an average of 7660 B.t.u. is assumed and the cost determination is made for three different cases.

CASE 1. Chain grate, burning coal only:

Efficiency of the boiler plant, per cent	70
Heat value of the coal, B.t.u. per lb	10,800
Cost of fuel per ton of 2000 lb	$1.67
Fuel required to yield 20,000,000 hourly B.t.u. $= \frac{20{,}000{,}000}{0.7 \times 10{,}800}$	2,465 lb.
= tons of 2000 lb	1.3
Consequent hourly cost of fuel = 1.3 × $1.67 =	$2.17

CASE 2. Chain grate burning coal mixed with 40 per cent. of locomotive cinder:

Efficiency of installation, per cent	65
Heat value of fuel mixture, B. t. u. per lb	9,550
Cost of fuel mixture per ton of 2000 lb	$1.26
Fuel required to yield 20,000,000 hourly B.t.u. $= \frac{20{,}000{,}000}{0.65 \times 9550}$	3,222 lb.
= tons of 2000 lb	1.6
Consequent hourly cost of fuel = 1.6 × $1.26	$2.01

CASE 3. Locomotive cinder only:

Assumed boiler efficiency per cent	60
Heat value of cinder fuel, B.t.u. per lb	7660
Cost of cinder fuel per ton	0.65
Fuel required to yield 20,000,000 B.t.u. hourly tons	2
Hourly cost of fuel = 2 × $0.65	$1.30

Anderson Safety Water Column and Steam Separator

Fig. 1 is a good idea of the operating mechanism of the Anderson safety water column. The parts are assembled in the removable hanger frame *A* and pivoted at *H*, *G* and *J*; the pins are held in place by the set-screws *J* and *N*. The hanger frame is secured to the interior of the water column.

With high water in the boiler the float *D* rises until it comes in contact with the top lever *B*, which causes the whistle-valve rod *K* to drop and the valve to open with the downward movement of *F*. At low water, the float falls and, coming in contact with the lever *C*, opens the whistle valve, through the lever *E*.

A section view, Fig. 2, of this water column, which is made by the V. D. Anderson Co., West Ninety-sixth St., Cleveland, Ohio, shows the sediment chamber at the bottom.

Fig. 3 is a phantom view of the vertical steam separator also made by this company. It consists of a shell, with the mouth of the outlet about midway of the body. It has a disk at the top of the same diameter as the spiral baffles, which are arranged above the outlet and around the bell-shaped deflecting piece shown.

Steam entering at the top of the separator and impinging on the baffles, is given a spiral movement and, passing

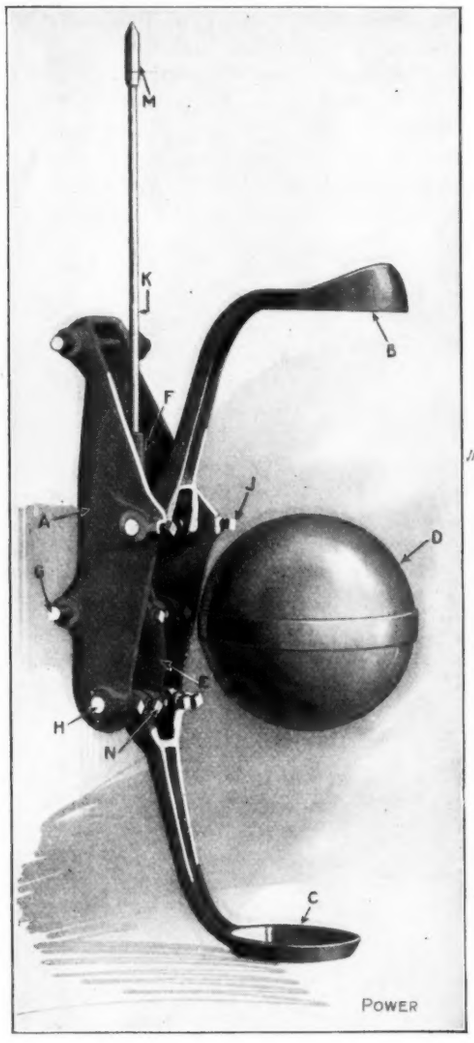


FIG. 1. OPERATING MECHANISM OF THE WATER COLUMN

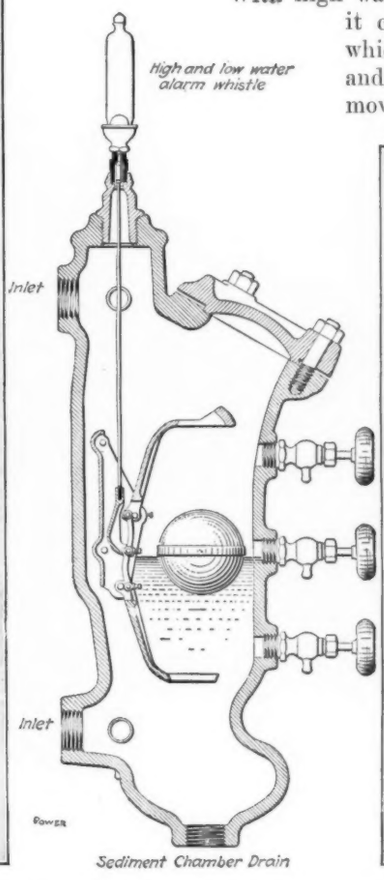


FIG. 2. SECTION THROUGH WATER COLUMN

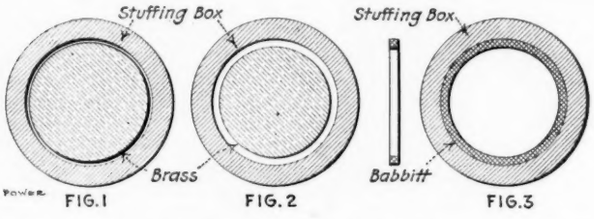
FIG. 3. PHANTOM VIEW OF STEAM SEPARATOR

around the edges of the bell center, escapes through the outlet at the bottom of the main body. All moisture separated from the steam drops from the baffles to the chamber at the bottom of the separator and is discharged through the outlet shown.

Some Pump Troubles and Their Remedies

By H. A. Gibson

A pump that had been running nicely for a long time, the valves in both the steam and the water ends being in good condition, suddenly developed a kick at the beginning of each stroke. The pump was taken down from one end to the other, in an effort to find the trouble. Then it was repacked, the setting of the steam valves was ascer-



New, Worn and Reinforced Pump Stuffing-Box

tained to be correct, and the water valves were carefully gone over. When the pump was again started up, however, the kick was still there.

Someone suggested taking down the suction pipe; it might be obstructed, thus preventing the usual flow of water. This was done, beginning at the pump and working back toward the heater. At a point not far from the pump, where the suction pipe turned down through the floor, a wad of excelsior was found lodged in the ell. In some manner the excelsior was dislodged from the feed-water-heater filter, and although the wad was only large enough to partially obstruct the suction pipe, it could not make the turn at the ell. Its removal from the line eliminated the trouble.

The boiler-feed pumps in the same plant are of the outside-packed, plunger type. After several years' use, one of them gradually developed a tendency to stick at the beginning of each stroke and refuse to start until more steam was turned on; it was particularly troublesome when the pump was working slowly. Under this condition, with the steam throttled to produce a slow action of the pump, it became practically impossible to regulate the speed—a case of either too much speed or no action at all. The indications pointed toward troublesome packing, so the stuffing-boxes were repacked. The pump worked smoothly for a time, then the old trouble returned and things were soon as bad as ever.

An examination disclosed that, due to several years of use, the plungers were so worn that the clearance space between the bottom of the stuffing-box and the plunger was enlarged. A consideration of the drawings will show the effect on the packing of this enlarged space.

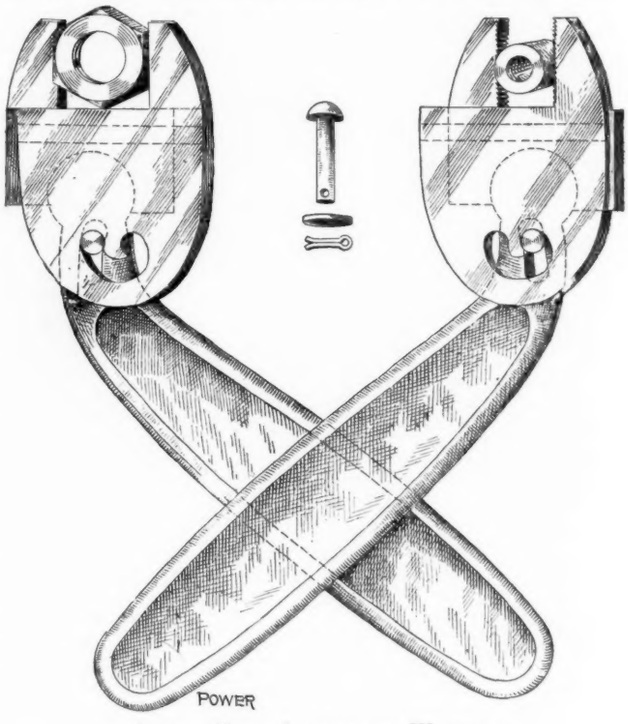
Fig. 1 represents a sectional end view of the plunger and the stuffing-box of a new pump; Fig. 2, that of the same pump after the plunger has been reduced in size by wear. In Fig. 1, the plunger clearance space is at a minimum; therefore, the edge of the packing next to the plunger has but little opportunity to become wedged in the clearance space. In Fig. 2, a different condition prevails. With the increased clearance space, there is less backing in the end of the stuffing-box for the packing. The edge of the packing next to the plunger is subject to a continual back-and-forth motion which tends to shorten its life, the packing soon breaks, and the pieces become wedged in the clearance space.

A remedy was effected by introducing babbitt rings into the stuffing-box before any packing was put in, Fig. 3. The rings were cast solid, the proper size for each box being found by measuring the outside of the plunger and the inside of the stuffing-box. It was necessary to take out the plunger to get the rings in place.

This method of treatment saved the expense of a new set of plungers and provided the equivalent of a new stuffing-box. Since the installation of the rings, the pump has given no trouble. The life of the packing has been greatly lengthened, a saving in that item and a consequent decrease in the time consumed in keeping the pump in repair.

Allan Self-Adjusting Wrench

A self-adjusting wrench which fits any size of nut within its capacity is illustrated herewith. In operation, the jaws are placed over the nut or pipe and a pull on the handle forces them to grip the object; the harder the pull,



Allen Self-Adjusting Wrench

the more forceful the grip. The jaws are released by pushing the handle in the opposite direction. This wrench has an instantaneous release and does not round the corner of the nut. On account of the handle being reversible, the wrench made by A. C. Allan, 420 West Sixty-third Street, Chicago, Ill., is handy for use in close quarters.

It is made in practically three parts, the handle and two jaws. When the handle is pulled, the jaws are forced together, the pin acting as a fulcrum. A reverse movement of the handle gives an opposite movement of the jaws. The curved slot gives different adjustments.

Editorials

Business Honesty

Some think the above two words have no place together Others would take it that the first qualifies the second, like "near silk"—sort of an imitation of the genuine article. While either view might have been justified in bygone days, we mark with satisfaction the increasing frequency with which the real thing is being found in business. Old as is the precept, "Honesty is the best policy," it was wont to be quoted with mental reservations, and, like affected piety, used where it might make an impression on the ingenuous. Now, more and more, people are realizing that instead of being merely a pretty copy-book maxim, it really means something. Soon, it is to be hoped, instances like the following will be too common to occasion comment:

An engineer wanted a pump to deliver against a high head, where the combination of conditions was rather peculiar. He had about decided on a certain type which he had selected from a manufacturer's catalog, but, wanting a little more data before buying, wrote the manufacturers, stating the conditions in his plant quite fully.

To his surprise, the manufacturers replied that although their pump would do the work, it was not as well adapted to it as a pump of different type manufactured by a competing company. Although their pump cost less and was smaller, it was not efficient enough for the high head required, and they therefore preferred to let the competitor have the business.

Without doubt this is the proper spirit and it is being displayed more and more by machine makers. In many instances big manufacturers are using competitors' machines themselves to perform certain work more efficiently than would be possible with their own type, for it is evident that, unless two machines are as much alike as two peas in a pod, one will have advantages over the other under conditions for which it was expressly made.

Users of power-plant machinery should realize and take advantage of this modern honesty. The manufacturers want customers to know that they are honest, but customers are prone to distrust them, because the old custom was to do almost anything to get business. Barnum, for instance, admitted it; today even the circus advertisements are mainly true.

When one wants to buy a machine for any purpose whatever, and is at all doubtful about the outcome of his selection, he need not hesitate to write to as many manufacturers as he will. Big, reliable concerns instruct their engineering correspondents to be frank. They can hardly afford to make unwarranted installations and ruin or jeopardize their names. Much less can a small concern afford to be tricky. It would have a mighty hard climb nowadays if some of its first installations were inefficient or failures. All manufacturers like to point with pride at all of their machines that are in use.

Manufacturers, as a rule, are ready to give their best advice to prospective purchasers. They employ engineers who know, and if these engineers know that the prospect is on the wrong path, they will usually guide him aright, as in the example mentioned.

It is safer to depend on the manufacturer, even though a stranger, than to rely entirely on one's own judgment.

The Human Element in Coal Sampling

For eight or ten years many large consumers have bought coal on what the dealers call a "scientific" basis, the coal being specified to contain not less than so many heat units per pound with certain proportions of fixed carbon, volatile, ash, moisture and sulphur. This scientific method is not always indorsed with enthusiasm by the dealer, who has to be more particular when coal is bought in this way than when it is just "ordered."

It is contended, and with reason, that if the dealer is compelled to meet the specifications drawn up by the consumers, the quality furnished will be satisfactory. Undoubtedly the quality will be more uniform, but it is common experience that there is more "kicking" by the consumer, for reasons real or apparent, when "scientific" purchasing methods prevail. Often coal will meet the specifications but produce poorer results than those of other shipments which may not have been bought on specification.

When the results are unsatisfactory, the consumer usually complains more bitterly than if the same coal were not purchased on specification. To appease the buyer, the contractor orders a testing laboratory to sample and analyze the shipment. Suppose the analysis does show that the quality is as specified, then the consumer is disgruntled. The contractor sells coal, not copies of its analysis. An unsatisfied customer with a cargo of what he thinks is poor coal on his hands is not made happy by an analysis sheet.

If a coal is not satisfactory and still meets the specifications, it is manifest that the specifications are not such as they should be. Physical characteristics like the fusing point of the ash, as indexes of the behavior and value of the coal, are as good as or better than chemical analyses or calorimetric determinations. The real test is in the amount of water it will evaporate, but too many and variable factors enter into that performance for the coal dealer to accept it as a measure of the value of his product. The contract should guard the purchaser against paying coal prices for bone, slate and water, and should so regulate the relations between fixed and volatile that the character of the coal may be uniformly adapted to the provisions made by the purchaser for using it.

Many contractors contend that a sample reduced before analysis to less than a tablespoonful is not representative of a shipment of hundreds of ton. They complain that the sampling is often left to mere boys or laborers, who, as one large contractor put it, "have perhaps been out the night before, who have no commensurate conception

of responsibility and who often gather a barrow load from one car or one place in the cargo and dismiss the matter with an 'Oh, that's good 'nough.'" Of course, if the sample is wrong, the most carefully made analysis is wrong.

As a fact the less one knows the better gatherer of samples is he likely to make. If he will take a scoopful from each car with his eyes shut he will get a fairer sample than a professional who would instinctively avoid or reach for certain pieces, or be influenced by appearances, which would mean nothing to the laborer and so have no effect on where he stuck his scoop.

Welded Drums

The abstract of a paper on the determination by experiment of the stresses present in the parts of cylindrical drums, due to internal pressure, which will be found on page 90, should be of much interest to all who are concerned with autogenous welding, as well as the design of boilers and similar vessels required to withstand high internal pressures.

Welds of all kinds are open to suspicion, because there is no way yet known, without the destruction of the weld, to determine accurately whether the parts have been properly joined together. In autogenous welds, there are added factors of uncertainty, owing to the internal stresses that may be set up by local heating of the parts and the uncertainty of the quality of the metal in the weld, after having passed through the heat treatment required to make it. Apparently, the only practical way that such internal stresses can be removed is by heating the entire welded surface to a fairly high temperature after the weld is completed, and this method of treatment is impractical in the average case where autogenous welding would be used, and particularly so in that of repairs.

The work these Australian engineers are doing, to find just how the stresses are distributed in the different parts of boilers and vessels of a similar character, cannot be too highly commended. It has been common to treat problems dealing with the determination of safe pressures for boilers and similar constructions as if the manner in which the strains were brought was very simple, while in reality it is probably most complex in some cases. It was unfortunate that the drums concerned in these tests had hoops around them, for undoubtedly this construction was responsible for the peculiar results shown in one of the drums, where a portion of the surface was found to be in compression rather than in tension. The results of experiments that are to be made by these same investigators on plain drums without hoops will be awaited with interest.

The distribution of stresses in the plates of a boiler around openings, such as manholes, handholes, etc., has long been an unknown quantity in the design of such vessels. The Martens mirror extensometer would seem to furnish a ready means for obtaining the necessary data, so that reinforcements for such openings could be designed without recourse to guesswork or rules of thumb. Some of our institutions of learning are now equipped with all the necessary apparatus for carrying on this class of experiments, and practically any of the first-class boiler makers of the country would be glad to furnish the necessary specimens gratis to permit a full investigation of the subject.

We should not let our engineering friends in the Anitpodes entirely outstrip us in the matter of making such investigations, and if not, we will have to commence this work at once.

Proper Valves and Fittings

In buying valves and fittings for power-plant service, it seems the prevailing custom to specify the sizes, types and pressures to be carried, but not to indicate what the service and general treatment will be. Further, there appears to be a tendency, probably with a view to economy, to use an article that is too cheap in the sense that it is often subjected to a higher pressure and a more severe service than that recommended by the manufacturer.

This practice frequently leads to considerable trouble, if not to actual expense, and as a consequence the manufacturer is often wrongly accused of selling an inferior class of goods.

It should be remembered that a valve or fitting is expected to withstand not only the actual pressure carried in the line, but also shocks due to water hammer, strains caused by expansion and contraction, abuse by ignorant or careless workmen and so on. Some of these cannot be foreseen, nor their extent anticipated. Some, however, although well known, are not given proper consideration. Also there are many instances where a certain valve, for example, must be opened and closed at frequent intervals, which makes the service more severe. Swing check valves especially are subjected to a hard and continuous service as well as to great and sudden shocks.

No doubt many valves and fittings are in use under higher pressure than that stipulated by the manufacturer, with no immediate bad results, but such practice is not true economy because of the early failures which are almost sure to happen. Moreover, it creates a source of apprehension and danger that is hardly worth the doubtful saving that might be considered as ensuing therefrom.

There are many uses to which the cheaper and lighter goods can be put satisfactorily, such as in suction lines, exhaust lines, etc. Also if pressures are fairly constant, piping is in good alignment, expansion and contraction are well taken care of and other conditions are favorable, it is sometimes possible to use them for pressures slightly higher than those for which they are recommended.

Such ideal conditions, however, are seldom realized; therefore, as a general rule, it is advisable to specify heavier equipment, even though it may seem unnecessarily strong. This will result in a larger margin of safety, an allowance for an increase in pressure should occasion arise at some later time, a longer life, and, consequently, fewer renewals. These advantages will more than offset any greater initial cost of installation.

Some day it will be unusual to see steam blowing from the roofs of building and mill plants. The escape of practically a thousand heat units for every pound of steam used will eventually be considered poor engineering, except in special cases.

Correspondence

Sporadic Motor Flashing

Most high-tension linemen can cite instances of trouble due to high-tension transmission conductors being wind-swayed into contact, or near contact, with each other or with a ground wire strung upon the same towers. Such incidents are not so common on low-tension systems because the spans are not so long, as a rule there are no ground wires; the conductors are well flanked by buildings, and more or less shielded from cross winds, and the working voltage has practically no arc-striking value.

In the following instance a 500-volt, 75-hp. shunt-wound shop motor of ordinarily perfect commutation characteristics became addicted to irregular flash-overs that apparently had no explanation. It was finally noticed that the flash-overs always occurred during high winds, so the transmission span from the building entrance bushings to the line pole, 250 ft. distant, was inspected. One of the line wires was off the pole insulator and this brought the wires close together at the center of the span, so that occasionally the movements, due to the wind, would cause them to touch each other. In course of time, the insulation had become abraded so that the conductors actually made contact.

At such times the motor became, for an instant, a short-circuited generator with a resulting speed check, due to a magnetic drag. If the short persisted for more than an instant, the acting generator lost its field. In either case, the separation of the line wires and the reintroduction of voltage to the motor found it unqualified to instantly generate a counter electromotive force of appreciable value; therefore, the current would be abnormal, the field weak, and the machine would flash over.

J. A. Horton.

Schenectady, N. Y.

Suggested Improvement for Boiler Setting

The chief object in using a boiler is to get good steaming results, and as Mr. Rockwell gets good results any criticism of the setting described on page 679 of the May 12 issue must be rather conservative, but I wish to offer a few remarks.

The shell of this boiler has about 200 sq.ft. of heating surface, and the tubes probably about 1600 sq.ft.; the latter make up the most important part of the heating surface. Complete combustion is as important as completely absorbing the available heat from the gases, and the place for scrubbing contact is in the tubes after the gases are completely burned. If the combustion chamber floor were lowered five feet at the back of the bridge wall, 100 sq.ft. would not have that scrubbing contact. Suppose that 100 sq.ft. were then only half as effective, so that the effect of 50 sq.ft. of heating surface were lost. That is about 3 per cent. of the heating surface, but the gases would be hotter than formerly when they reached the tubes and would partly offset the 3 per cent. loss. A larger combustion chamber with soft coal should easily improve combustion enough to more than offset that slight loss, especially with a heavy load. The grates being 4 ft. from the shell is good and give some space for combustion without a large chamber back of the bridge-wall. I would not expect a large gain, but think there would surely be some improvement in evaporation and less smoke if the floor of the combustion chamber back of the bridge-wall were lowered four or five feet.

Harry D. Everett.

Fort Snelling, Ariz.

Building a Smokeless Furnace

In his criticism (Power, May 26, page 747) of my article on the above subject in the issue of Apr. 21, H. Misostow intimates that the use of air ducts connecting the ashpit and the space above the grate cannot be as beneficial as stated, and calls on me to experiment to determine the course taken by the air entering above the grate as it comes through the ducts. He also states that a boiler should be adapted to the fuel it is to burn.

It is quite common practice in western New York to design furnaces under boilers with a straight bridge-wall 14 in. high and to set the boilers from 30 to 36 in. above the grates. This is because there were times when, owing to strikes, soft coal was unobtainable, and plant owners were obliged to burn anthracite in place of bituminous at any price. It is obvious that stores and industrial plants would not shut down their plants and change the furnace construction to burn hard coal when the cost is $6 per ton compared with $2.50 and $2.75 for bituminous.

As to jacketing the boiler shell with hot air with the aid of three or four ducts on each side of the furnace, this was tried with $\frac{5}{10}$ in. of draft in the ashpit, the grates blanketed and the damper partially open, before any furnace of this kind was put into service. Wads of tissue paper were placed near the intake ducts and lighted before the ashpit doors were closed, instead of using oiled waste as Mr. Misostow suggested. From these openings in front of the underside of the shell the very blanketing that I spoke of does occur.

Further evidence to prove this is presented by the following case: About two weeks ago an engineer had a mason reline one of the furnaces. From my office window I noticed quite a large volume of smoke coming from this particular stack which, since the use of the air ducts, had not smoked. The engineer informed me that the mason had closed the ducts in relining the furnace, but they were going to be opened for they were not only causing smoke, but more fuel was consumed for the same output.

The latter part of the winter two other large plants were similarly equipped. One of them uses a slight forced draft and behaves the same as the first installation referred to, and no smoke is emitted from the stack.

The other smokes slightly at the moment of most rapid distillation of the fuel, the smoke being pale gray from one minute to nearly two. The stack produces all the draft; there is no forced draft used to cause the heated air to cross beneath the shell. Air, entering the combustion chamber from the ducts, takes a course partly across the furnace and then to the rear instead of covering the underside of the shell.

F. A. SHOEMAKER.

Buffalo, N. Y.

Caring for the Ammonia Piston Rod

Among the trouble-making fixtures in an ice plant is the ammonia piston rod. The trouble, however, is limited or done away with when, in the first place, the best packing is used, and when the stuffing-box is packed properly. It is important that ammonia-compressor packing be regularly lubricated.

Should the rod become hot, it indicates that the packing is to tight and should be loosened, the gland lowered straight, so that it will not touch the rod on one side and scratch it. If the rod gets so hot that the packing commences to smoke, the latter will soon be ruined and the rod injured. It is best never to entirely fill the stuffing-box with packing, for one is likely to get the gland on crooked and scratch the rod.

When the frost comes back so heavy that it enters the ammonia cylinder, the rod will contract and even the best of packing will leak. Many engineers immediately tighten the gland of the stuffing-box in order to stop the odor of ammonia. In case the frost comes back that heavy (a thing which should not happen), the main liquid valve should be closed for a while, leaving the gland alone. If tightened, the rod will get hot and spoil the best of packing as soon as the frost disappears. Some engineers are too impatient to wait until the frost goes away, even when the liquid valve is closed. If the gland is tightened, one should watch the stuffing-box and loosen the gland when the frost disappears.

WILLIAM L. KEIL.

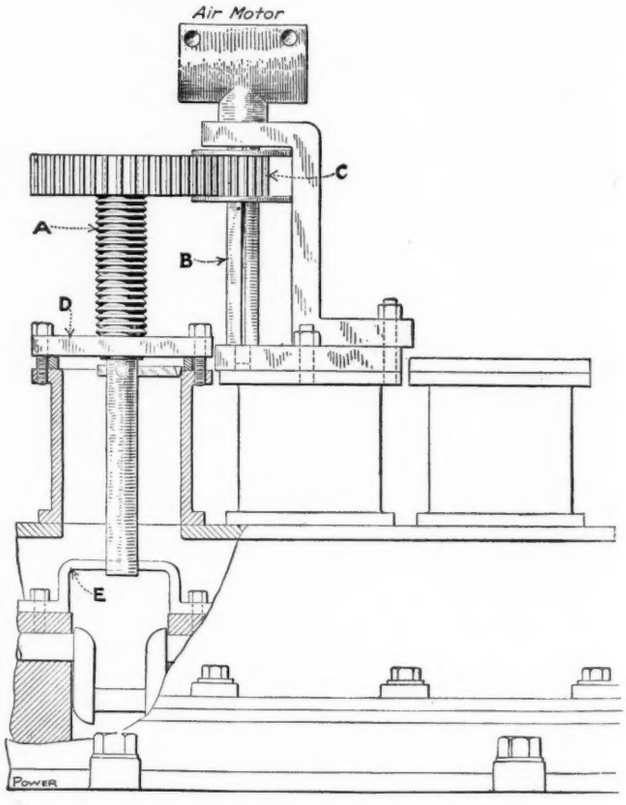
Philadelphia, Penn.

Boring Out Cylinders

The writer successfully bored out a three-cylinder, 6½-in. diameter air compressor with the rig shown herewith. The air was passing through and giving poor compression. After boring the cylinders and renewing all the pistons, which were badly worn, we are getting good efficiency. The illustration shows a side view of the boring and driving bars assembled.

The boring bar *A* had a thread which acted as a feed when revolved. The plate *D*, when drilled and tapped, was fastened down by the cylinder-head studs on top of two parallel strips, and it acted as a guide for the boring bar *A*. Driving bar *C* was supported by a brace. On the driving bar a small gear, free enough to slide up and down, acted as a drive to the main gear, which was keyed to boring bar *A*. There was a keyway the full length of the driving bar and a key which fitted in this small gear. To keep this gear from falling down and out of alignment with the main gear, two plates were riveted on its sides. The bottom guide plate *E* supporting the boring bar was fastened to the crankshaft-bearing studs.

With this rig, all that was necessary to do the job was to remove the top covers and pistons, and throw the cranks to one side to allow room for the boring bar. An



CYLINDER BORING RIG

air motor furnished the power for driving, and the gears used were taken from a lathe. Half-inch square steel, fastened by a setscrew, was used as a cutter.

J. M. CARTER.

Vancouver, B. C., Canada.

Allowable Fine Coal in Coal Shipments

In connection with the purchase of coal on the B.t.u. basis, there is an important point that should not be neglected, namely, the allowable percentage of fine coal or slack. This, in nut and slack contracts, generally reads that the coal that can be sifted or screened through a screen having perforations one-fourth inch in diameter shall not exceed, say 30 per cent.

In preparing coal for a calorimeter test it must first be pulverized; consequently the purchaser would not be protected from too much fine coal by such a test. When much of the coal is very fine it gets through the grate and the combustible in the ash is increased greatly, although the analysis may show the coal as being of contract grade.

JOHN F. HURST.

Louisville, Ky.

One Way to Set an Engine

Last week one of our mechanics set a 75-hp. engine on a timber foundation for temporary use. The instruments used were a battered carpenter's level and square. When started up, as was to be expected, the engine developed several varieties of hard knocks. Upon turning it over slowly the brasses and the space between the crank disk and bearing could be seen to open and close during each revolution. The shaft was then squared and leveled by observing this opening, which effectually eliminated the pound. The engine, a double-eccentric, side-crank Buckeye, has seen 30 years' service, and deserves better treatment. Probably old age has made it somewhat philosophical.

JAMES A. BARR.

Mt. Pleasant, Tenn.

A Quick Line-Shaft Repair

Our 3⅞-in. main line shaft broke about 4:30 p.m., shutting down more than half the machinery of the plant. The break occurred about 7 ft. from the end of the shaft. When it happened a fan engine was made to drive the shaft by coupling two shafts and only one blower was left idle out of the entire number of machines belted to this shaft. The engine, a 70-hp., high-speed unit, was terribly overloaded, and when examined later the front half of the crankpin box was broken in two and the bolts holding the straps were partially sheared. How it held together in this condition I do not know.

The plant was many miles away from a machine shop, but as soon as the coupling was disconnected the measurements were taken for a new shaft and coupling, and they were telephoned to the shop. These measurements were

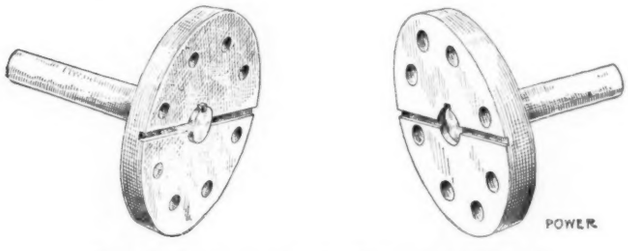


FIG. 1. COUPLING WITH KEYWAY ON FACE

the outside diameter of the coupling, the depth and diameter of the socket, the diameter of the bolt circle, the number and size of the ream-fitted bolt holes, the diameter and length of the shaft, the number and size of the keyways. Special care was taken to get the measurements correct.

The shop worked all night on the job and delivered it for use at 11 o'clock the next morning. At 1 p.m. the main engine was shut down and the new shaft put up. The small engine was stopped long enough to uncouple and to put on two large belts, and we had the new shaft running at 5 p.m., a little over 24 hr. from the time of the break. The measurements and work were so accurate that not a single bolt hole had to be reamed, and the plug and socket portion slipped together just right.

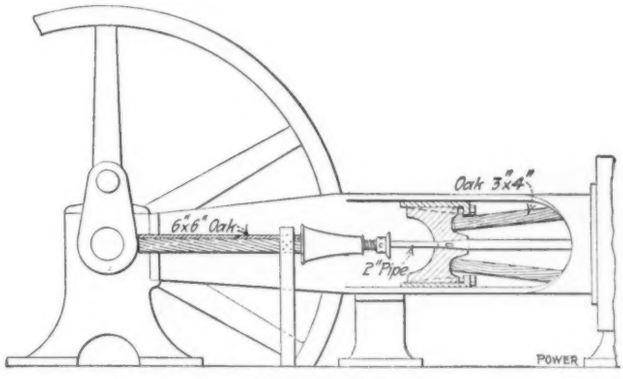
Fig. 1 shows the halves of a coupling where the shaft extends through one half and lacks the same amount of coming flush with the face of the other half, thus forming a plug and socket, serving the same purpose as the one described. In large couplings keys are put in between the flanges to avoid the shearing strain on the bolts. The entire plant was stopped 2½ hr. in all, and a part, including the broken length, 5 hr.

R. A. CULTRA.

Cambridge, Mass.

Getting a Crosshead Off

The engineer who has never attempted to remove the piston rod from the crosshead of a large engine has an interesting piece of work before him. The sketch shows the low-pressure side of a 24x52x60-in. cross-compound Corliss engine. The piston rod was so badly scored that no packing could prevent leaking more than a few days following each packing.



RIG SET UP

It was decided that a new rod and metallic packing would be a good investment, so I set to work to remove the rod. Fig. 1 will show my method which, though not new, may help someone. A 6x6-in. oak was placed against the crank hub, supported as shown, and a 15-in. piece of extra heavy 2-in. pipe was used for an arbor.

After blocking the crosshead, a 28-in. lever was used in the jack and screwed up nearly as hard as one man could. Not a move! I struck the rod next to the crosshead with a copper hammer and it let go with a report like a gun. After replacing a new rod and metallic packing, everyone felt repaid for working on a holiday.

A. C. WALDRON.

Revere, Mass.

Soda Ash in Boilers

Soda ash as a solvent has many advocates, especially where water from deep wells is used. While some claim that it will cause priming and numerous other troubles, I have found that these boilers prime because they are dirty and not enough attention is paid to blowing down while in this condition to get rid of the disintegrating scale and the concentration of salts. As the boilers become clean the necessity for frequent blowing down becomes less. In a plant using as much as 2⅜ lb. per 1000 gal. it is necessary only to blow down twice in 24 hr.

At first there is generally noticed a deposit at the caps or at any other place where there is a slight leakage; this will usually disappear as the scale is removed. The greatest foe to the successful use of soda ash is ignorance or carelessness. A variation in the treatment—the water

remaining the same—will make more trouble than a uniformly low treatment. The latter will cause the formation of scale, but a high treatment one day and a low treatment the next will give rise to various troubles, such as tube burnouts, etc.

A simple way to determine the proper amount of soda ash is to take a sample of the water after treatment, and filter it into two test tubes, running about 1½ in. into each; then onto one of the tubes put about five drops of calcium-chloride, heat the tube, and if the treatment is correct there should be noted a slight turbidity. It requires a little practice to determine the slight trace required, but a comparison of one tube with the other, with and without the calcium-chloride, will assist greatly.

JOHN F. HURST.

Louisville, Ky.

Cutting Out Mica on Commutators

To insure good commutation, it has become usual to reduce the mica at the surface of commutator bars. Practice differs somewhat as to the shape of the groove; some favor the V-shape, claiming that it eliminates the accumulation of dust or carbon, while others maintain that with this type of groove a part of the mica projects above the copper at the sides, and still prevents proper contact between the commutator and brushes. It is more general, therefore, to reduce the mica the full width of the slot to a depth of about $\frac{1}{32}$ in.

Most firms adopt this reduction of mica on all but very small machines, such as domestic or fan motors, and the practice proves justifiable if a soft brush of a graphite nature or a hard or variable quality of mica is employed. Such grooving is also successful on machines which are heavily overloaded, even if the period of overload or sparking is short, for in time the commutator bars will pit or burn to such an extent that the mica projects above the surface of the commutator.

Where soft green mica or Canadian silver amber mica is used, certain firms only groove their commutators under the special circumstances mentioned and employ annealed mica built up in sheets with a minimum of varnish or binding left in. In such cases, it is usually claimed that the mica wears down evenly with the copper, and that the mica troubles are mainly due to defective pressing and annealing of the commutator during manufacture. They regard the grooving merely as an expedient which is resorted to on large or heavy-current machines only.

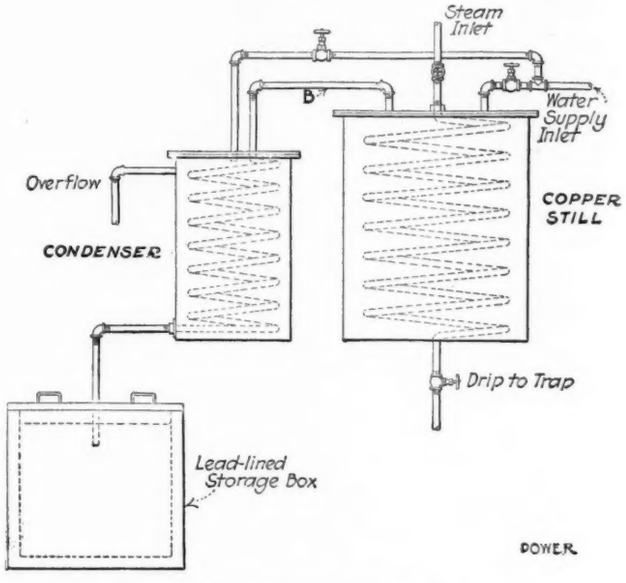
J. S. FOSTER.

Manchester, Eng.

Distilling Water for Storage Batteries

Where storage batteries are used, it is necessary to have pure water in diluting the strong acid and for replacing that evaporated from the cells when gassing. It is often found economical to distill this water on the premises. A good outfit for this purpose is shown in the accompanying sketch.

This consists of a closed tank, or still, with a copper-pipe coil running through it, the coil being connected to a trap and drain at the bottom. City water is admitted to the space surrounding the coil until the tank is about two-thirds full. Steam is then admitted to the coil, which evaporates the water at atmospheric pressure, and the vapor passes up through the pipe *B* to the condenser, which is an open vessel containing a coil of copper pipe. City water is allowed to flow over the coil and condense the vapor, which is drained out at the bottom into a lead-lined tank, where it is kept until needed.



DISTILLING SYSTEM

The still will hold about 30 gallons of water, 20 gallons being admitted at each filling; about 3½ hours are required to evaporate and condense this amount. The storage box holds 40 gallons. Care must be taken in distilling the water, for if it is permitted to boil rapidly, it will be carried over through pipe *B* in small globules.

Water taken from iron pipe lines is likely to contain more or less iron-rust or a tincture of iron, which is injurious to the plates in the cells. Earthenware or glass jars can be used for storage tanks, but there is liability of breaking, therefore lead-lined boxes are preferable.

Some time ago, I took charge of a plant where there were two storage batteries. One was in bad condition and, wishing to save as much of the electrolyte as possible, I had a sample analyzed; it contained much iron. As all the cells were affected, this led me to suspect the tank, and upon looking into it, found part of a mason's trowel badly rusted. The carpenter had been doing some masonry work around the building and had slipped the trowel up over a piece of molding back of the tank. The fireman usually filled the battery cells, and it is supposed that he must have knocked down the trowel while the box was open, and did not notice it, or forgot to take it out of the box.

R. A. CULTRA.

Cambridge, Mass.

Indiana Coal Production in 1913—The production of coal in Indiana in 1913 was 17,165,671 short tons, valued at $19,001,881, according to Edward W. Parker, of the United States Geological Survey. Although this was an increase of 1,879,953 short tons, or 12.3 per cent., over 1912, it fell short of the record output of 1910 by more than 1,200,000 tons.

Home-Made Sink for the Plant

A stand made, as illustrated, out of ½-in. round iron with a ring large enough to hold a good-sized enamelware pan will be found a convenience. A ¾-in. pipe, fitted with a rubber stopper, may be soldered to the bottom of the pan for a waste pipe.

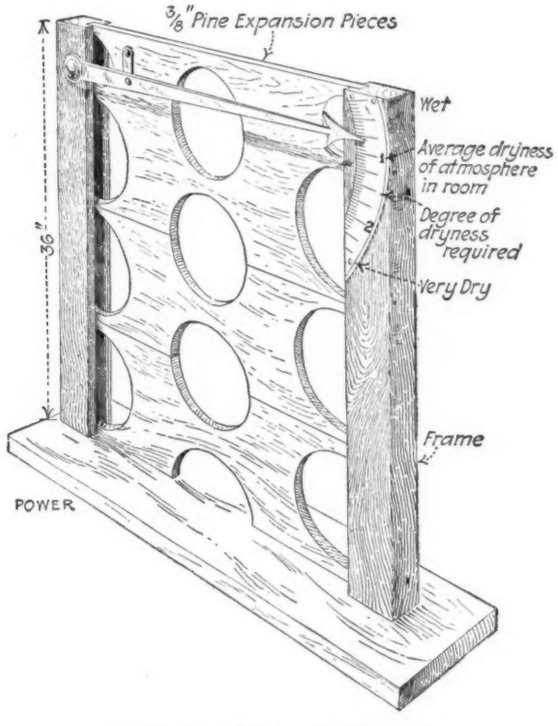
The sink is set under a hot-and-cold-water outlet and the waste pipe runs through the floor and connects with the sewer. The pan may be lifted out and the stand removed when necessary.

CHARLES C. JOHNS.

McClellandtown, Penn.

Easily-Made Hygrometer

In woodworking plants instruments called hygrometers are used to indicate the degree of dryness of the stock, or how much moisture the air contains after being passed through the drying kilns. It was the custom to put the lumber into drying rooms heated to a high temperature to extract the moisture and season the lumber, but until the hygrometer was invented the degree of dryness could not be determined. The hygrometers on the market were only suited for rooms with a temperature less than 100 deg. F., and when placed in a hot drybox it would become distorted and worthless after a few weeks.



A DRYING-ROOM HYGROMETER

The drying rooms and boxes often ran as high as 180 deg., different boxes being kept at different temperatures according to the stage of the work, and it became an item of expense to keep supplied with hygrometers. It was not a question of the room temperature, but of the dryness and the proportionate amount to increase the temperature with each degree of humidity. Soft pine will absorb moisture rapidly and it expands and contracts quickly.

An indicator was made with upright side pieces attached to a base for a frame. The inside edges of the uprights were grooved and ⅜-in. pieces of dry pine boards were shaped and put between the uprights, as shown. A pointer was attached to one of the uprights and connected by a link to the pine pieces. By comparison with a hygrometer, a scale was marked on the opposite side.

As the moisture causes the pine to swell, the pointer will rise and indicate the degree. As the air becomes dry the pine will shrink and the pointer will drop toward the bottom of the scale. By noting these changes and the temperatures at the time it is possible to keep the room at a steady degree of humidity.

This device costs less than the metal instrument on the market and will last a lifetime; the temperature of an extremely hot room will not injure it. The measurements are 36 in. high by 10 in. wide and ⅜ in. thick. It can be set on the floor or hung up, as desired, without affecting its operation. It is also useful in office rooms to indicate the relative humidity of the air.

R. A. CULTRA.

Cambridge, Mass.

The Reading Habit

There is a particularly broad significance to POWER'S editorial under this caption in the June 9 issue. It drives home a message that we all need, even though the postscript does tend to "let us down easy" on this point. Between the lines it intimates the distinction of the reading habit and the habit of proper reading, and careful consideration shows that such difference is marked.

The former, if on a hit-or-miss plan, may or may not afford substantial benefits; the latter shapes and molds a future, transforms a possibility into a reality. The spirit that actuates the habit of proper reading is the spirit that prompts the best one can do.

This term "proper reading" carries a double significance, relating to the character of matter and the manner of perusal. As to character of matter, the answer is self-evident, for every single hour given over to general and popular reading two hours should be accorded to technical literature directly, and sometimes indirectly, relating to our field. The first pays dividends in a knowledge of universal happenings and current topics; but the other pays double dividends in a wider knowledge of our world's work. To skim over the pages of this book or that technical journal aimlessly and listlessly, without any distinct concentration, is useless. The habit of proper reading is not defined in "killing time"; for this, other and more profitable ways (to one's health) may easily be found.

To read intelligently, to digest, to reflect and analyze and remember is to add notches to one's ability. Rich thoughts make the mind rich, and to concentrate the

attention where richness in one's field of endeavor is afforded is taking advantage of an often overlooked opportunity. The secret of success emanates from the brain, and a well fed mind is but a forerunner of bigger things.

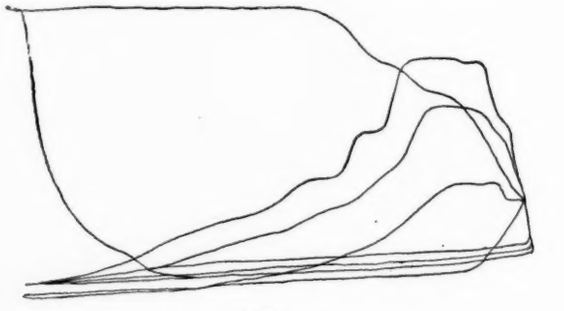
Notice the difference between the man who has the habit of proper reading and the one who has yet to get it. The contrast should be an inspiration to acquire the habit of careful, consistent and conscientious technical reading.

L. R. Warde.

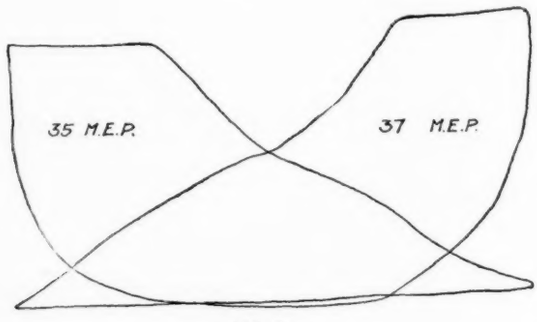
Newark, N. J.

Odd Diagrams Caused by Excessive Friction

The indicator diagrams shown were taken from an automatic engine the speed of which had been cut down. The governor is of the type which has the double weights



NO. 1



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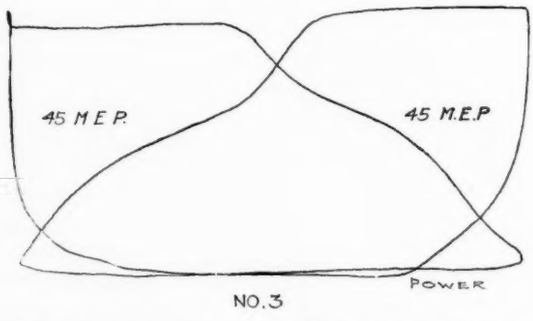
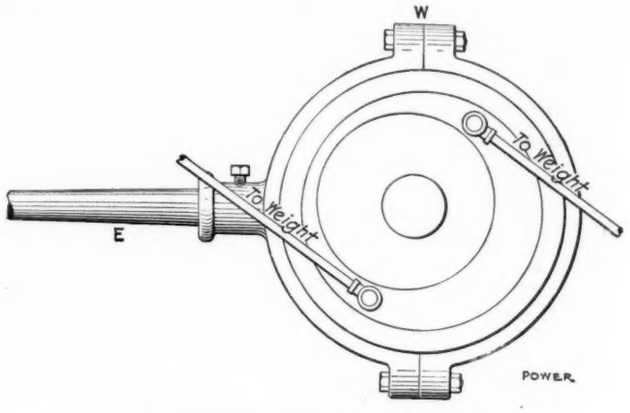


NO. 3

Diagrams before and after Decreasing Eccentric Strap Friction

and the eccentric collar works around a fixed "boss" on the shaft.

This engine was noisy, it would not pull its load and its governing was unstable. By holding up with the hand at the point *E* on the eccentric rod, the engine would run quietly. The eccentric strap was drawn up too tightly, which caused the governor to produce diagrams like No. 1. By putting in a liner at the point *W* and clamping the strap up, the engine ran smoothly and produced diagrams Nos. 2 and 3 under heavy loads.



Eccentric Strap Too Tight

This is another instance in which it is clear that the working parts in an automatic governor should not bind.

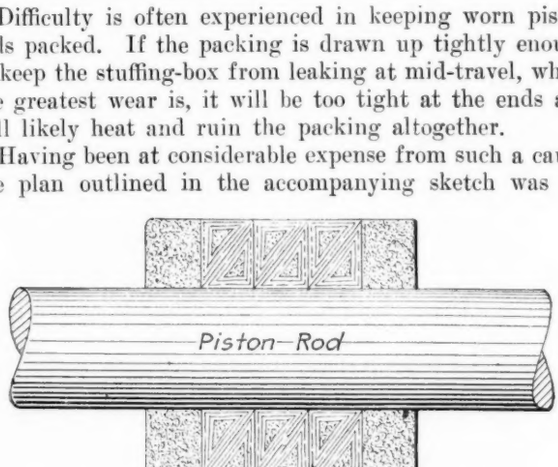
C. R. McGahey.

Baltimore, Md.

Packing a Worn Rod

Difficulty is often experienced in keeping worn piston rods packed. If the packing is drawn up tightly enough to keep the stuffing-box from leaking at mid-travel, where the greatest wear is, it will be too tight at the ends and will likely heat and ruin the packing altogether.

Having been at considerable expense from such a cause, the plan outlined in the accompanying sketch was hit



Packings Used

upon, and it proved valuable. The capacity of the stuffing-box was five rings of packing. Two rings of finely woven, shredded brass were procured from the packing dealer. One was placed in the bottom of the stuffing-box or next to the cylinder, three rings of ordinary wedge packing were then inserted and the other brass ring put in last.

Only slight tension is required, as the packing seems to give best service when left free to expand and contract. The brass rings at the ends perform the function of holding the packing in place and will usually last several years.

Edward T. Binns.

Philadelphia, Penn.

Peculiar Engine Characteristic

A man was hired to operate a 24x48-in. Corliss condensing engine in a wire mill. All went well for a few days, then a peculiar thing happened. The new man got the engine ready to start as usual, opened up to the condenser; the vacuum was 26 in.; opened the throttle, but "nothing doing"; gave it more steam, but there was no move—looked as if that was all that could be expected to cause an engine to start. Used both starting bars and connected up again, gave her nearly full throttle. Not a move!

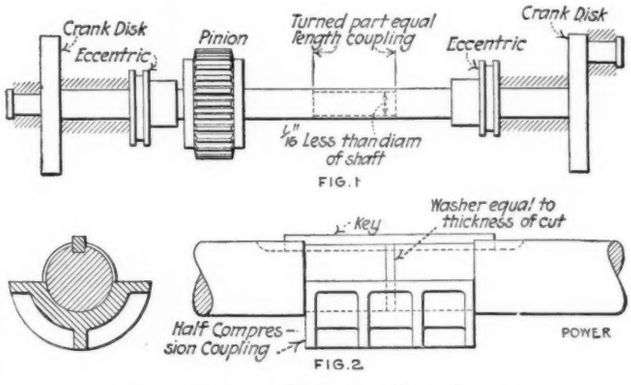
The time for starting was nearly up when the night man came in. He had seen the same thing happen before in this plant. He used the starting bar on the exhaust valves, giving them a sharp, quick jerk, throwing them down onto their seats—they were hung up. The engine had to start under full load; therefore the blowing through was fatal.

M. W. Carter.

Webster, Mass.

Repairs to Hoisting Engine

The illustration shows a job I had to do recently. A double 10x12-in. hoisting engine had a badly worn pinion which had to be replaced. The pinion and eccentrics were put on the shaft and the crank disks pressed on afterwards by the manufacturer. This required either the removal of one of the disks or cutting the shaft so as to remove the pinion or the eccentrics. The disks were not keyed on the shaft, but depended solely on the press fit. If a press fit has been tampered with, it does not afterward have its original strength, and even if the



Shaft Cut to Put on New Pinion

disk were replaced without injury after changing the pinion, the same problem would arise when similar repairs again became necessary.

Having decided to cut the shaft and join it again, with a compression coupling, the shaft was first turned down $\frac{1}{16}$-in. a distance equaling the length of the coupling. It was then keyseated for a key equal to the length of the coupling. The coupling was then bored and fitted accurately. The shaft was cut and a filling disk made the thickness of the cut. This, with the shoulders of the shaft, insured the exact original length of the shaft. Removing the pinion and placing the new one was a simple matter. The ends of the shaft were butted together with the filling washer between, and the compression coupling with the key in place was bolted in position. When the shaft was set up it ran perfectly true.

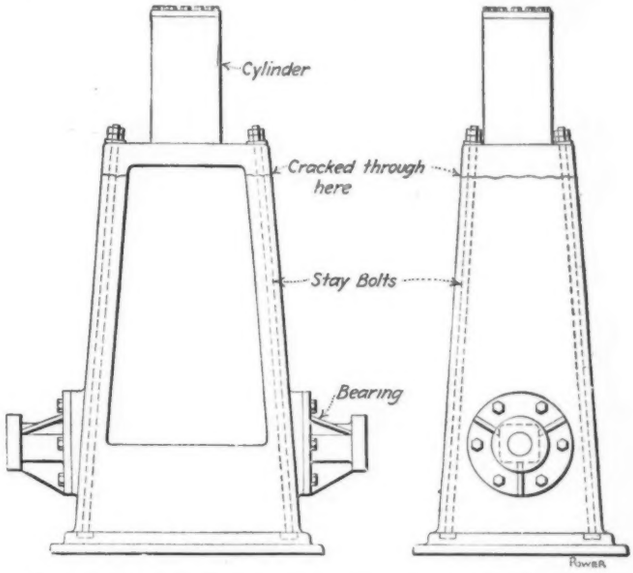
It was put into service and has been working 24 hours a day for six months at 250 r.p.m. The repair has not given a minute of trouble.

B. P. Luce.

Fajardo, Porto Rico.

Repair to a Broken Standard of a High-Speed Engine

The standard was broken off at the place shown in the sketch. As it was impossible to get a new one for some time, it had to be repaired in the following way: Four $\frac{5}{8}$-in. bolts were put in the corners and tightened, and to



Dotted Lines Show the Position of the Bolts

prevent the head from moving sideways, iron pieces 3 in. long, ¼ in. thick and ¾ in. broad were fixed inside of the standard. The job turned out to be most satisfactory.

J. B. Joshi.

Bombay, India.

Settling Chamber for Coke

On nearly every type of open heater employing coke as a filtering medium, a certain amount of fine coke will find its way to the feed pump and pipe to make trouble. If the water is not very bad, a good plan is to lay one sheet of about ⅛-in. perforated copper under and one over the coke, but the great danger then is running too long and getting the perforations choked up with scale and coke grit.

By far the most satisfactory type of heater is that which has a large settling and storage capacity beyond the filter. I have had success with excelsior. Charcoal (animal) also gives splendid results, but it requires too much changing and cleaning; the first cost is also much too high for ordinary use. Coke seems to hold the field, but for the past three weeks I have been experimenting with quartz. The water having an upward flow through

it, the direction is reversed for a few minutes each night to wash out the dirt. So far it has given entire satisfaction.

E. R. Pearce.

Rochdale, England.

Corliss Valve-Gear Wreck

This broken valve-gear, of the single-wristplate type, had this list of broken parts: The exhaust arm on the left side and the bell crank on the right were broken off; the wristplate stud was broken at the shoulder, showing an old crack, so that only three-quarters remained good; the steam-valve stem was bent upward, making it impossible to remove it from the hood without force; the valve hood was broken off at the shoulder; the dashpot rod on the right side was so loose from the plunger that it could pulled out easily.

The loose dashpot rod was the cause of the accident, its bottom end being pulled out of the plunger; the plunger did not raise at all. Therefore, there was no cut-off on this end, and when the bell crank came down to pick up the steam arm on the next stroke, the pin holding the hook spring was still up from the previous stroke. This pin could not push the steam arm down because the rod did not go back into the plunger to its original position, and the steam arm could not be pushed down. If the flaw in the wristplate stud had not existed the dashpot rod might have been bent or the bell crank and the arm levers broken off.

This accident goes to show the minute care and attention valve-gears require.

Albert H. Israel.

New York City.

Assembling a Centrifugal Pump

In assembling the impellers of a multistage centrifugal pump, great care should be taken to get the slots or the orifices in the impellers exactly in line with the openings in the diffusion vanes. If the water strikes the vanes at an angle, it will cause a thrust sufficient to crush the metal in the thrust bearing. If the members are keyed in place, the adjusting can be done by the thrust collars.

In many instances, where the thrust bearings run hot, the trouble is due to wear permitting the shaft to work endwise, so that the impellers are thrown out of line.

John Fairfax.

Louisville, Ky.

Hospital-Plant Experience

For over three years I have been chief engineer of a hospital plant. The year previous to my taking charge of this plant the water bill was $1372; last year it was $691. We have one ten-ton refrigerating machine, and this is where I made the saving in water. The water was run over the ammonia condenser, then to the steam condenser and into the sewer; the boilers were fed from another line.

I piped the condenser water to the boiler feed heater at a cost of about $5, saving both water and coal. The coal bill the year previous was $5200, and last year it was a little less than $5000, with an advance in price of about 40 cents per ton. This was brought about partly by cleaning the boilers and the feed-water heater. The feed-water temperature was increased from 150 to 210 deg. The boilers had about four inches of loose scale

I have the satisfaction of knowing that my salary can be paid from the savings alone; I think that is pretty good. An engineer is not always hired for what he does as much as for what he knows, and if he does not stop leaks when he sees them he is not worthy the name.

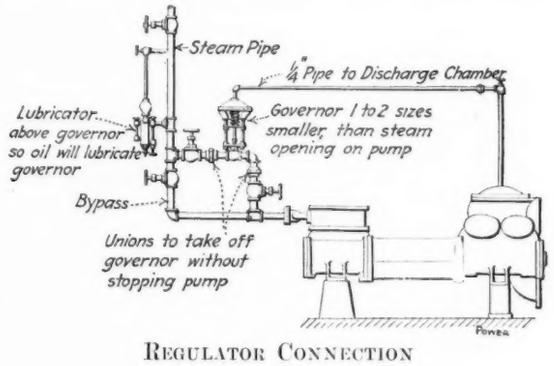
We are developing one horsepower-hour with 3.35 pounds of coal, actual test, and the engineer who has conducted a number of tests in this locality says that there are few plants doing better.

A. G. C. McKalip.

Pittsburgh, Penn.

Connection For Pump Governor and Lubricator

An automatic pump governor is often put directly in the steam line, but the proper way is to put it on a by-pass, with valves and unions as shown. The governor can then be taken out to be repaired without stopping the pump. Of course, the pump will have to be regulated by hand while the governor is out. A quarter-inch pipe


Steam Pipe
¼" Pipe to Discharge Chamber
Lubricator above governor so oil will lubricate governor
Governor 1 to 2 sizes smaller than steam opening on pump
Bypass
Unions to take off governor without stopping pump
POWER

Regulator Connection

should be connected from the governor to the discharge chamber of the pump.

A double-connection lubricator should always be placed above so that it will lubricate the governor. It will be noted also that the valves have their stems either vertical, with the handwheel above, or horizontal. If the valves are placed with their stems turned down, any leaks through the stuffing-box will burn the hand when operating the valves.

J. E. Poch

New Orleans, La.

Caution to Beginners

The beginner handling the jet type of condensing apparatus is likely to overlook an essential point—i.e., the speed of the air pump. The smaller-sized outfits have but one pump performing the combined function of an air and water pump. The water flows to the pump and the only check as to its amount is the opening of the inlet or injection valve (not the speed of the pump). Consequently, if the pump is not operating fast enough, there is a chance of flooding. The operator must see that the pump is constantly operating with a distinct jump at each end of the stroke, which indicates that the pump is running ahead of the water.

H. F. Johns.

Louisville, Ky.

Inquiries of General Interest

Solving Proportion by Slide Rule—In the proportion 6 : 14 : : 30 : x how is the value of x found on a slide rule?

C. G. T.

Set the slide so that the division 6 of the slide comes opposite 1.4 on the scale, then the division 3.0 standing for 30 on the slide will be opposite 7.0 standing for 70, the value of x.

Dry Saturated Steam—What is meant by dry saturated steam?

T. H.

Steam that is at the evaporative temperature corresponding to its pressure and which contains no water held in mechanical suspension, i.e., it is steam which is neither wet nor superheated.

Relative Evaporation with Iron and Copper Tubes—What is the relative evaporative capacity of fire-tube boilers fitted with iron or copper tubes?

A. J.

Tests of two boilers made exactly alike except that one had iron fire tubes and the other copper fire tubes showed that their evaporative activity was practically the same.

Effect of Oil on Concrete—What effect has oil on cement concrete?

C. S. T.

Mineral oil has no appreciable effect on the strength of concrete, but animal and vegetable oils have a tendency to disintegrate concrete by the solvent action of acids which they liberate upon decomposing.

Greatest Pitch Taken as Unit Length—In figuring the strength of butt and double-strap joints, why are the calculations based on the pitch of rivets of a row having the greatest pitch?

M. D.

Any other unit of length of joint might be employed, but the computations are simplified by assuming the greatest pitch as the unit. ?

Advantages of Superheated Steam—What is the advantage of using superheated steam expansively in an engine?

G. B.

The chief advantage from using superheated steam is the prevention of initial condensation. The higher the degree of superheat the drier the steam at cutoff, and with the degree of superheat high enough, cylinder condensation may be entirely prevented.

To Find the Length of Belting in a Roll—How can the length of a belt be found from measurement of the roll and number of turns made by the belt?

R. G.

Add together the diameters of the roll and of the eye both measured in inches, and multiply the sum by the number of turns. This product multiplied by 0.1309 will give the length of the belt in feet.

Clearance—What is the difference between engine clearance and piston clearance?

G. B.

Engine clearance is the volume included between the piston, when at the end of its stroke, and the seats of the valve at the same end of the cylinder. Piston clearance is the distance the piston would have to travel beyond the end of its stroke to strike the cylinder head.

Weight of Water at Temperature of Steam at 100-Lb. Boiler Pressure—What is the weight per cubic foot of water in a boiler when the water is at the temperature for generating steam at 100 lb. per sq.in. boiler pressure?

S. T.

To generate steam at 100-lb. boiler pressure or 114.7 lb. absolute, the water would be at a temperature of 337.9 deg. F., and at that temperature it weighs 56.02 lb. per cu.ft.

Evaporation from and at 212 Deg. F.—In considering the performance of a boiler what is meant by equivalent evaporation "from and at 212 deg. F."?

G. R.

The evaporation that would have resulted from the transfer of the same amount of heat when the feed water is supplied at 212 deg. F. and the steam is generated at a pressure equal to the normal atmospheric pressure, or 14.7 lb. absolute. Under these conditions the steam would be generated "at" 212 deg. F. "from" water at 212 deg. F.

Difference of Expansion in Vertical Boiler—What would cause inequality in expansion of the outside sheets and tubes of a vertical fire-tube boiler?

E. M. S.

From coatings of nonconducting materials on the inside of the boiler the outside sheets would be at a lower temperature and the tubes would be at a higher temperature than that of the water and steam, and there would be a difference in expansion due to the difference of temperatures of the materials. There is also a difference in expansion of the shell and of the tubes due to difference in structure of the materials.

Cushion Valves on Duplex Pump—What is the purpose of cushion valves on a duplex pump?

J. P.

When the piston in the steam cylinder passes over the inner or exhaust ports no further exhaust steam can escape and without cushion valves, whatever steam then remains in the cylinder acts like a cushion by being compressed between the piston and cylinder head. This compression may be excessive and by means of cushion valves, which connect the outer or steam ports and passages of the cylinder with the inner or exhaust passages, the amount of compression can be reduced by permitting the escape of more or less of the compressed steam into the exhaust passage by way of the steam passage.

Use of Steam Siphon with Compressed Air—Why will not a steam siphon raise water when operated by compressed air?

J. M. D.

Because the form of the siphon is not adapted to the use of compressed air. A steam siphon operates by condensation of steam within the steam tube and by continuation of the velocity of the steam as condensate. After leaving the tube the air and water ahead of the tube are driven forward to the discharge outlet of the siphon accompanied by a relief of pressure from the suction chamber. When compressed air is used it has a tendency to expand upon leaving the tube and unless the tube and surrounding spaces are sufficiently favorable to concentration of the energy of the air beyond the water outlet, expansion of the air causes back pressure in the suction chamber, which hinders siphonage in the same manner as when the suction chamber is filled with uncondensed steam.

Force Required to Stop a Body—In what time and space will a weight of 640 tons moving at a velocity of 44 ft. per sec. be brought to rest by a resistance of one ton?

W. R. B.

The acceleration of gravity is 32.16 ft. per sec., and the force of gravity acting on a mass weighing 640 tons will bear the same relation to the acceleration of gravity as the resistance one ton bears to the acceleration or retardation which is created; i.e., calling the retardation x,

$$640 : 32.16 : : 1 : x, \text{ or } x = 0.05 \text{ ft. per sec.}$$

As time = velocity ÷ acceleration, the time required for bringing the mass to rest would be

$$\frac{44}{0.05} = 880 \text{ sec., or } 14 \text{ min. } 40 \text{ sec.}$$

and as the space covered would be ½ the initial velocity × time, the space required would be

$$\tfrac{1}{2} \times 44 \times 880 = 19{,}360 \text{ ft.,}$$

or

$$\frac{19{,}360}{5280} = 3\tfrac{2}{3} \text{ miles.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.]

Engineers' Study Course

Elementary Mechanics--XVIII

Last Lesson's Answers

76. From equation (33)

$$a = \frac{V^2}{2S}$$

where a = The desired acceleration;
V = The velocity, 44 ft. per sec.; and
S = The space, 800 ft.

Hence, $a = \frac{44 \times 44}{2 \times 800} = 1.21$ *ft. per sec. per sec.*

77. From equation (40)

$V_1^2 = U^2 - 2aS$, or $2aS = U^2 - V_1^2$

where U = 66 ft. per second;
V = 22 ft. per second; and
S = 1000 ft.

Therefore,

$$a = \frac{U^2 - V^2}{2S} = \frac{66^2 - 22^2}{2 \times 1000} = 1.936 \text{ ft. per sec. per sec.}$$

78. An acceleration of 2 ft. per sec. per sec. means that for every second the body is in motion the increase or gain in velocity is 2 ft. per sec. Then the gain in velocity in feet per minute for every second the body is in motion would equal 60 × 2 or 120 ft. per min. per sec., which is to say that at the end of one minute the body would be moving with a velocity of 120 ft. per sec. Likewise the gain in velocity in feet per hour would equal 120 × 60 or 7200 ft. per hour per sec. Since there are 5280 ft. in a mile, 7200 ft. will equal $\frac{7200}{5280} = 1.36$ miles. Hence an acceleration of 2 ft. per sec. per sec. is equivalent to an acceleration of 1.36 miles per hour per sec. Now if the velocity is increasing at the rate of 1.36 miles per hour for every second the body is in motion, then for every hour the body is in motion the gain in velocity would be 3600 × 1.36 = 4896 miles per hour. Therefore, an acceleration of 2 ft. per sec. per sec. is equivalent to an acceleration of 4896 miles per hour per hour. This shows that the value of a given acceleration varies directly as the square of the factor changing the unit of time, and inversely as the factor changing the unit of length.

79. From equation (39)

$$V_1 = U - aT \text{ or } a = \frac{U - V_1}{T}$$

In this problem
U = 88 ft. per sec.;
V_1 = 22 ft. per sec.;
T = 20 sec.

Hence,

$$a = \frac{88 - 22}{20} = \frac{66}{20} = 3.3 \text{ ft. per sec. per sec.}$$

80. From equation (40)

$$V_1^2 = U^2 - 2aS \text{ or } S = \frac{U^2 - V_1^2}{2a} = \frac{88^2 - 22^2}{2 \times 3.3}$$

$$= 1100 \text{ ft.}$$

Uniform and Accelerated Motion (Continued)

Space may be represented graphically by an area, just as the work done in an engine cylinder is proportional to the area of the indicator diagram. It has previously been shown that the space traversed by a body is the product of the average velocity times the time; therefore, for an area to represent space, the base of the figure must represent time and the altitude of the figure represent the velocity of the body.

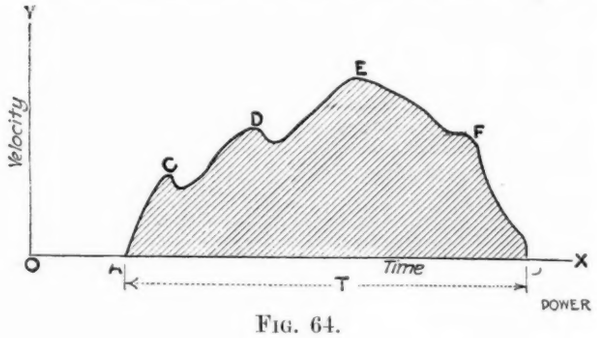


Fig. 64.

Thus, in Fig. 64, let the distances measured parallel to the axis OX be proportional to the time, and the distances measured parallel to the axis OY be proportional to the velocity of the body. Now suppose a body moves for an interval of time indicated by the line AB and during this time the velocity varies as shown by the irregular line $ACDEFB$, then the space passed over by the body will be given by the area $ACDEFBA$, for this area is equal to the product of the base AB (which corresponds to a certain interval of time) and the altitude which is the average height of the figure and represents the average velocity. In a case like this the average velocity can be obtained by dividing the figure by vertical lines into 10 or 20 smaller areas, measuring the mean height of each and finding the average height of them all.

A graphical representation affords an easy method for becoming familiar with the formulas for uniform and accelerated motion. In Fig. 65 let the line AB represent a given interval of time of T sec.; let the line AC be the initial velocity U of the body in feet per second; and the line BE give the final velocity V_1 of the body. Draw the line CD parallel to AB. Evidently the line DE will be the gain in velocity during the interval of T seconds, since the line $DB = AC = U$. But this gain in velocity is equal to the acceleration times the time or aT. The figure, then, shows at a glance that the final velocity V_1 is equal to the initial velocity U plus the gain in velocity which is aT, or

$$V_1 = U + aT$$

which is the same as equation (35).

If the body is moving with a uniform velocity, only the space traversed in T sec. will be equal to the area $ACDBA$ or UT. Likewise if the body starts with an initial velocity of U ft. per sec. and moves for T sec. with an acceleration of a ft. per sec. per sec., then the space passed

over will be given by the area *ACEBA*, which may be divided into the two areas *ACDBA* and *CDEC*.

$$area\ CDEC = aT \times \tfrac{1}{2}T = \tfrac{1}{2}aT^2.$$

(The area of a triangle equals the product of one-half the base times the altitude); and the area *ACDBA* equals *UT*. Hence

$$area\ ACEBA = UT + \tfrac{1}{2}aT^2$$

or the space passed over is the same as by equation (34).

Again, if the body is moving with a deceleration in addition to its initial velocity, then the space traversed will be given by the area *ACFBA*, where the line *DF* equals the loss in velocity or *aT* (of course, in this case *a* is the deceleration in feet per second per second). But

$$area\ ACFBA = area\ ACDBA - area\ CDFC$$
$$= UT - \tfrac{1}{2}aT^2$$

which is the same as given by equation (38).

Falling Bodies

Gravity attracts all bodies toward the earth with an acceleration which varies with the location of the body relative to the center of the earth. This acceleration is the same on all bodies, independent of their size, shape or weight. If a feather and a lead ball were put in a vessel from which all the air had been removed, it would be found that both objects would fall at the same rate. However, if the ball and the feather were dropped from the top of a building it is evident that the ball would reach the ground long before the feather, simply because the resistance of the air acts as a retarding force on the feather to a greater extent than it does on the ball. Further, if a body falls under the action of gravity alone, the velocity of the body will increase at a uniform rate. The acceleration, due to gravity, may be determined experimentally by the use of the Atwood machine, which will be described in a later lesson. For all practical purposes, the value of this acceleration may be taken as 32.16 ft. per sec. per sec., and throughout the remaining lessons the letter *g* will be used to denote the *acceleration due to gravity*.

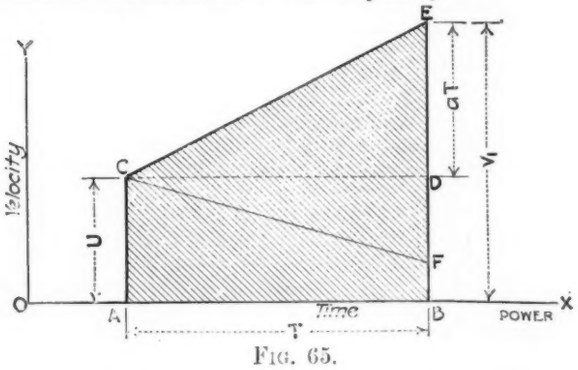


Fig. 65.

If a body be dropped from the top of a tower, the velocity will increase at the rate of *g* ft. per sec. for every second the body is falling, thus at the end of the first second the velocity will be 32.16 ft. per sec., at the end of the second second it will equal 2 × 32.16, or 64.32 ft. per sec., or, in general, *if an object starts from rest and falls under the action of gravity, the velocity at the end of T_1 sec. will be gT_1 ft. per sec.*

Let V = the final velocity in feet per second. Then,

$$V = gT_1 \qquad (41)$$

The average velocity will be the sum of the initial and final velocities divided by 2 or

$$\frac{0 + gT_1}{2} \text{ or } \tfrac{1}{2}\,gT_1$$

and the distance the body has fallen in the given interval of time will equal

$$\tfrac{1}{2}gT_1 \times T_1 \text{ or } \tfrac{1}{2}\,gT_1^2.$$

Let H equal the vertical distance the body has fallen. Then,

$$H = \tfrac{1}{2}\,gT_1^2 \qquad (42)$$

But, from equation (41)

$$T_1 = \frac{V}{g}$$

Substitute this value of T_1 in equation (42) and there results

$$H = \tfrac{1}{2}\,g \times \frac{V^2}{g^2} = \frac{V^2}{2g}$$

or

$$V_2 = 2\,gH \qquad (43)$$

Problem—A wrench is let fall from the top of an elevator shaft which is 200 ft. deep. What is the velocity of the wrench when it reaches the bottom of the shaft? How long did it take the wrench to fall?

Solution—To find the velocity substitute the value of *H*, which in this case is 200 ft., in equation (43) thus,

$$V^2 = 2\,gH = 2 \times 32.16 \times 200 = 12{,}864$$

or

$$V = 113.4\ ft.\ per\ sec.$$

The time of flight may be found from equation (41), where $V = 113.4$ and $g = 32.16$, hence

$$T_1 = \frac{V}{g} = \frac{113.4}{32.16} = 3.5\ sec.$$

Assume a body projected vertically upward with an initial velocity of *U* ft. per sec. Then neglecting the friction of the air, if it were not for gravity the body would continue to move up with a velocity of *U* ft. per sec. However, the instant the body starts upward gravity exerts a deceleration of *g* ft. per sec. until the body is finally brought to rest at a certain height above the ground. The time that will elapse before the body comes to rest may be found by the use of equation (39) in which case $V_1 = 0$, $a = g$, $T = T_1$. Hence

$$0 = U - gT_1 \text{ or } U = gT_1$$

and,

$$T_1 = \frac{U}{g} \qquad (44)$$

The instant the velocity becomes zero, the body will immediately start to fall with an acceleration of *g* ft. per sec. and at the end of a certain time will reach the ground with a velocity equal to that with which the body was projected upward.

Study Questions

81. Does the acceleration due to gravity increase or decrease with the distance of the body from the center of the earth?

82. An object dropped from the top of a steel stack, takes 4 sec. to reach the ground. Find the height of the stack.

83. A ball is thrown vertically upward with a velocity of 84 ft. per sec. When will the ball's velocity become zero?

84. In problem 82 how far was the object from the ground at the end of the second second?

85. A standpipe 50 ft. high is filled with water. With what velocity will the water leave a nozzle at the base of the standpipe? (Assume all the head converted into velocity.)

Correction—In Elementary Mechanics—III, Apr. 7, 1914, the answers to problems 8 and 9 should have been 1276 lb. in both cases, instead of as given.

Heating Engineers Meet at Cleveland

The semi-annual meeting of the American Society of Heating and Ventilating Engineers, held at the Hollenden Hotel, Cleveland, Ohio, on July 9, 10 and 11, was well attended.

The first session was called to order by President Samuel R. Lewis, who complimented the members on their promptness in attendance and in behalf of the society thanked those who had furnished papers early enough for the secretary to send copies to the members in advance of the meeting; in so doing, authors of papers promote the welfare of the society by stimulating interest in the meetings, encourage the attendance of members and render material assistance to the officers and members in conducting the proceedings.

The first paper was by the president, in the form of an address on "The Importance of Proper Perspective," in which he stated that one of the limitations of the human mind is its normal inability to become sufficiently detached to view things in their proper perspective. After taking the utmost care in refining some detail of a process, we operate for years in combining such refinement with redundant, unconsidered rules-of-thumb. We are prone to follow precedent at the expense of progress. Too often we fail to view a clear perspective.

The most elaborate computations will be made, for instance, of heat losses, pipe sizes and radiator surfaces, affecting possibly one-third of the cost of an installation, and then we find that the designer guessed at the chimney size or type or height, took an incompetent manufacturer's rating on a boiler, or rendered abortive his own detailed computations by assuming that the manufacturer's competitive guess as to the capacity and efficiency of his particular apparatus was correct.

There are many questions in heating and ventilation demanding a better perspective. We refine the artificial heating plant, spend time, dollars, skill and genius in elaborating the heat-transmitting appliances and the fuel-consuming devices, with no more than a cursory investigation of the type of construction of the building, and with no effort to influence its construction so as to reduce the heat losses.

There are instances where 5 per cent. of the cost of the building, expended on heat transmission insulation rather than on a larger heating plant, saved, in fuel charges alone, its cost within three years. This is a field which is almost unexplored. We know, however, that an ordinary sawdust-packed icehouse with respect to heat insulation is much more efficient than an ordinary dwelling, and how much longer heat is retained in an ordinary fireless cooker than in the best insulated transmission equipment of an ordinary heating plant.

We know that poor insulation of walls and windows is the greatest enemy of good ventilation, preventing proper diffusion of the fresh air; that tight windows or storm sash permit of considerable fuel savings, and that warm winter buildings are cool summer buildings, but we seem unable to get enough perspective to use this knowledge. Buildings with rattling windows and no storm sash, thin walls, cold attics and cellars, direct-indirect radiators, unduly high ceilings, single slab roofs, etc., coupled with the most elaborate and expensive heating plants, should cease to exist.

In our practice as engineers, are we losing perspective in regard to the location in the room of the heat source? Heat transmission varies, among other things, in a certain proportion as the difference in temperature between the hot and cold objects varies. Is it, then, the best practice to place the hottest thing in a room against the coldest object? With reasonably tight windows and fairly well insulated walls, the radiator may be alongside the inside wall as satisfactorily as alongside the outside wall. May not the radiator be smaller, will not the piping be less expensive, will not the fuel cost be low, if this procedure is carried out consistently?

Is it not a loss of perspective to cling to the idea that air for ventilation shall all have been heated prior to its entry to a room? Our belief in this is traditional. Is it based on truth? It has been demonstrated that unheated air, when introduced into rooms under certain conditions, feels better than air which has been heated. This process has proven good for street cars. Shall we not hope for the development of the process for buildings, so perfected that it shall operate continuously and effectively? It will surely follow the construction of properly insulated buildings.

Is our perspective normal as affecting air-cleaning apparatus? Are there no natural processes from which we may take a hint aside from the reduction of atmospheric dust by rain? Will not our progress accelerate when moisture content and dirt removal from air are seen clearly as separate processes? Is it impossible to bring forth an air cleaner which shall operate continuously, economically and efficiently at less original and maintenance cost than the modern commercial air washer, and thus become more popular by doing for our homes, at least approximately, what our nasal functions do for our lungs so much more efficiently than any of our artificial cleaners? By the inspiration of contact, the members of the society gain a clearer perspective of the problems of their profession, and with that clearer perspective there is greater alertness in grasping elements of success.

A discussion commendatory of the paper followed its reading, and the remainder of the first session was taken up by reports of special committees and the reports of the committees on "Heat Transmission of Direct Radiators," by J. A. Donnelly, chairman; "Reducing Fire Risks in Blower System," by A. M. Feldman, chairman; "Standardizing a Method of Testing Air Washers," by A. E. Stacy, Jr., chairman. No action was taken on the report of the committee on "Coöperation with Other Societies on Adopting a Standard for Flanges," C. R. Bradbury, chairman.

The report of the special committee on "Coöperation with Educational Committee of National District Heating Association" was referred to the publication committee for the council to pass upon.

The second session was held during the afternoon, and was occupied by the reading and discussion of many topics of professional interest. Through the courtesy of President Lewis, this session was presided over by Prof. John R. Allen, M. E., of the University of Michigan, past-president of the society. The first business was the reception of the report of the special committee on "Model Compulsory Ventilation Law," by J. D. Hoffman, chairman. There was an interesting discussion of the committee's report by Messrs. Weinshank, Chapman and others, and the discussion was clarified by the lucid guidance of Prof. Allen.

D. L. Cooke presented a paper on car ventilation, which showed surprising thoroughness with which systems of ventilation had been devised for passenger cars and how difficulties had been overcome. Descriptions were given of successful applications of the most approved principles of ventilation. Discussion of this paper was taken up along with that on "Electric Car Heating and Temperature Control," by W. S. Hammond, nonmember and vice-president of the Consolidated Car Heating Co., which was read by the secretary. This paper presented many interesting facts and statistics on car heating, showing the advantages of electric heating service for cars and fallacies of arguments that have been advanced as to the extravagance of this system of car heating.

Among other data of interest, it was stated that steel cars require at least 30 per cent. more heat than wooden cars having the same capacity, and that the number of people in a car perceptibly affects the amount of heat required, tests seeming to show that the body of a man gives out about twice as much heat as that of a woman, the records showing a variation from 198 B.t.u. to 400 B.t.u. per individual, varying with external temperature and character of clothing worn. Therefore, when 10,000 B.t.u. per hour are required for maintaining proper temperature of a car, at the rate of 200 B.t.u. per person per hour, the car would be sufficiently heated by the presence of 50 persons. The practical bearing of this is that if heat is supplied at a uniform rate it would result in overheating during the periods of heavy traffic.

By automatically controlled electric heating a comfortable degree of heat can be maintained, and at the same time it allows the use of the extra power for propelling cars at times when travel is the heaviest. The paper also calls attention to the fact that it would be but fair for a company considering the advisability of employing electricity for car heating to consider, not the proportionate cost of current consumed, but rather to charge against the heating system only the cost of additional current.

A paper on "Radiation Needed for Exposed Kitchens when Gas Is Used for Fuel" was presented by J. A. Donnelly, and one on "Natural Gas Heaters" was read by O. J. Heunhold. The discussion of these was merged with the special topics for discussion on "The Economy of Heating by Natural

Gas" and "To What Extent Can We Economically Use Manufactured Gas for Heating?"

A discussional letter bearing on the use of manufactured gas, from R. P. Bolton, was read by the secretary, in which Mr. Bolton stated that from data which he had collected in relation to the cost of coal for heating at a typical New York City heating plant during those months of the heating season which require but little heat, he was persuaded that there should be a very decided saving by the use of manufactured gas as fuel at such times.

George S. Burrows, nonmember, of the United Gas Improvement Co., of Philadelphia, being present, was called upon for information on the subject of the use of manufactured gas for heating purposes. The speaker showed that he had been extensively engaged in encouraging and extending the use of manufactured gas with special regard to warming buildings, and could hardly state that 80-cent gas could compete with $6 coal for warming by the best appliances developed to the present time. There is, however, a broad field in the use of manufactured gas where the saving of labor, cleanliness and convenience are of greater consideration than the first cost of fuel, but before manufactured gas can successfully compete in cost with the grades of coal ordinarily employed for heating buildings, there will have to be radical changes in relative cost, and sweeping improvements in methods of burning gas in steam, hot water and other types of heating apparatus.

A discussion on the employment of natural gas for heating purposes, in which many of the members participated, revealed the consensus of opinion that natural gas could not be satisfactorily employed as fuel for heating apparatus, unless in specially designed furnaces, and that the requisites of coal-burning furnaces of designs usually given to heating apparatus make their employment for gas burning awkward and inefficient. From the testimony of members present from various sections where natural gas is available, the experience has been quite uniform that, in consequence of the increase in price and shortage of supply during colder portions of the heating season, consumers have generally had to fall back on coal as a fuel during the coldest part of the heating season. For that reason, and to cover uncertainties in the supply, heating apparatus suitable to coal burning is generally regarded as indispensable, and in view of the inadaptability of the usual coal furnace designs to gaseous fuel, natural gas can rarely be employed alternately or in combination with solid fuel without providing a special furnace for each, the usual method being to employ a gas heater connected to the ordinary forms of coal-burning boilers.

The third professional session was held on the morning of July 10. "Reduction or Elimination of Noise in Mechanical Ventilating Apparatus" was the subject of a paper presented by R. W. Pryor, Jr. A paper having for its subject "Ozone and Ventilation," by M. W. Franklin, brought out a spirited discussion on the efficacy of artificially produced ozone, whether its presence afforded more than a mask for offensive odors and whether in ventilation the actual destruction of odors which accompany noxious exhalations might not be beneficial physically through psychological influence.

The concluding professional session was convened on the morning of July 11, the first paper being presented by Norman A. Hill on "The Heating Industry in Canada," in which the author touched upon the peculiarities of Canadian trade practice, and practices in steam vapors and hot-water heating, and the absence of air conditioning, together with comments on contract practices and opportunities for manufacturers of ventilating and heating apparatus.

R. P. Bolton read a paper on "Hydro-Electric Power Compared with Steam," claiming that the burden carried in development of water powers was not generally warranted in competition with the cost of developing power by steam, and that the problem of coal conservation is rightfully within the province of those branches of engineering which are devoted to the economical development of heat. The only other paper read was presented by Secretary J. J. Blackmore, on "Our Society, Its Aims and Opportunities," which was replete in words of enthusiasm and encouragement.

Before adjournment, President Lewis took occasion to congratulate the members on the success of the meeting, which he said was largely due to the perfect arrangements and untiring efforts of the reception committee, Messrs. J. H. Bacon, Jr., W. H. Kingsbury, R. S. Mayer, F. G. Phegley and F. H. Valentine.

GROUP OF MEMBERS AND GUESTS AT SEMI-ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, CLEVELAND, OHIO, JULY 9-11, 1914

The president's expressions of appreciation were warmly seconded by remarks of several members, and after tendering the reception committee a vote of thanks for their successful labors the meeting was declared adjourned.

EXCURSIONS AND ENTERTAINMENTS

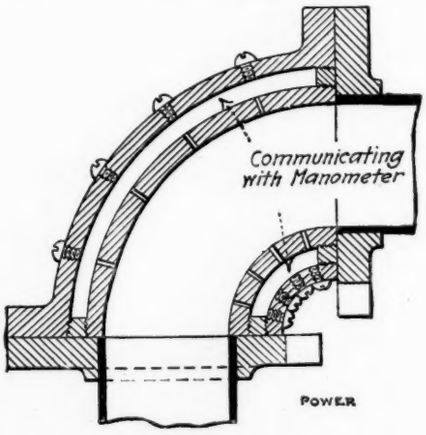
On the afternoon of Friday the members, ladies and guests of the society made a visit of inspection to the laboratories of the National Lamp Works of the General Electric Co. at Nela Park, where they were agreeably entertained and instructed by an illustrated lecture on "Effects of Direction and Distribution of Light," by Dr. M. Luckiesh, of the Physical Laboratory of the National Electric Lamp Association. The party was then conducted to the instruction and recreation camp of the company, where, under the courteous guidance of L. H. Britton, manager of sales department, and his assistants, inspection was made of the lamp company's complete and extensive provision for entertaining delegations of its employees and instructing them in the technical and commercial branches of electrical illumination. After partaking of refreshments furnished by their hosts, the party returned to the Hollenden with impressions of a delightful half day's outing.

Other entertainment provided by the reception committee consisted of automobile trips for the ladies, a musicale and refreshments in the assembly room of the Hollenden on Thursday evening, group shopping tours for the ladies, a banquet at the Hollenden on Friday evening, and on Saturday an automobile trip for the ladies to Euclid Park and return.

Flow Metering Apparatus

At the recent meeting of the American Society of Mechanical Engineers, A. M. Levin described an apparatus for measuring the flow of steam or other fluids in closed channels. Instead of determining the velocity of the fluid from its inertia pressure, as in the pitot tube and the venturi meter, the centrifugal pressure is measured as the fluid passes through an elbow. This elbow, as shown in the cross-section, is provided with suitable pressure ports through which the pressures may be transmitted to an ordinary U-tube manometer.

The formulas relating to this flow-bend are of the same form as those applying to the pitot tube, except that there is prefixed a multiplier which depends on the ratio of the diameter or width of the channel to the mean radius of curvature of the bend. Where the density of the fluid remains constant, the expression for the velocity is



METERING BEND

$$Vm = \sqrt{\frac{p}{2D}} \times \sqrt{2gH}$$

Vm = Mean linear velocity:
p = Mean radius bend;
D = Diameter of pipe or width of channel;
g = 32.16;
H = Difference in pressure at outer and inner walls of bend as measured by the manometer and expressed in feet head of the fluid.

The second term of the expression ($\sqrt{2gH}$) is that ordinarily applying to the pitot tube.

Notes on Operating High-Tension Transmission System

The report of the "Engineering Data Committee," recently submitted at the Detroit convention of the A. I. E. E., contains much valuable information relative to the practices of power companies supplying high-tension transmission systems. The material is compiled from the replies of twenty-five companies each transmitting at 25,000 volts or over.

Neglecting much of that part of the report dealing with construction features, some of the questions and answers relating more particularly to the operating practices are in abstract as follows:

Of the twenty-five systems, only two are exclusively hydro-electric, one exclusively steam and the remainder combination.

Seventeen companies employ a grounded neutral, most of them, however, through little or no resistance.

Electrolytic lightning arresters are employed by sixteen companies; three use the horn gap; one both horn gap and electrolytic and two multigap and electrolytic. One small system in California transmitting at 60,000 volts, does not use any lighting arresters at all. Twelve charge the electrolytic arresters daily, one twice a day, and three twice a day in winter and three times in summer. The majority charge through no resistance.

To open a short-circuit on the line, which holds on, the general practice seems to be to reduce the voltage of the generators. One company, however, separates the system into sections and cuts out the step-up transformers on the high-tension side.

Automatic overload relays appear to be used generally, and are of both the definite and inverse time limit type. The overload settings range from 100 to 300 per cent. overload and the definite time limits from ½ to 10 seconds.

The majority of the companies reported inability to carry a synchronous load through a heavy main line short-circuit, although a few claimed to be able to do so under such conditions when the arc was cleared by arc suppressers. The practice of nearly all the plants in locating line trouble is to sectionalize the line and test with the generator voltage and the patrol. One company uses a wheatstone bridge for this purpose, and two others employ a special loop test.

While most of the companies have had no trouble with oil switches, one reported trouble due to breakdown of the bushing from lightning or surges. Another had experienced trouble from repeated operation on short-circuits without overhauling, while a third said the type H-3 and K-10 switches had always opened short-circuits successfully, but sometimes the switches were nearly wrecked.

With regard to the use of reactance to balance charging current, one company reported the use of shunt inductance coils at one end of the line. These have a loading value of 2000 kv.-a. and are arranged for being cut in by steps. They have been found valuable in tying together two plants with little voltage disturbance.

Flywheel Explosion at Union Brewing Co., St. Louis, Mo.

At 1:25 a.m., on June 29, a flywheel burst, on a 100-ton ammonia compressor, at the Union Brewing Co.'s plant in St. Louis. A general diagram of the engine room and its surrounding is shown in Fig. 1. The flywheel was 14 ft. in diameter and 13x16-in. cross-section of rim, made in halves and secured by bolts through flanges in the rim and hub; it weighed 40,000 lb. The compressor was operated normally at 50 r.p.m., and was the largest of three in the plant.

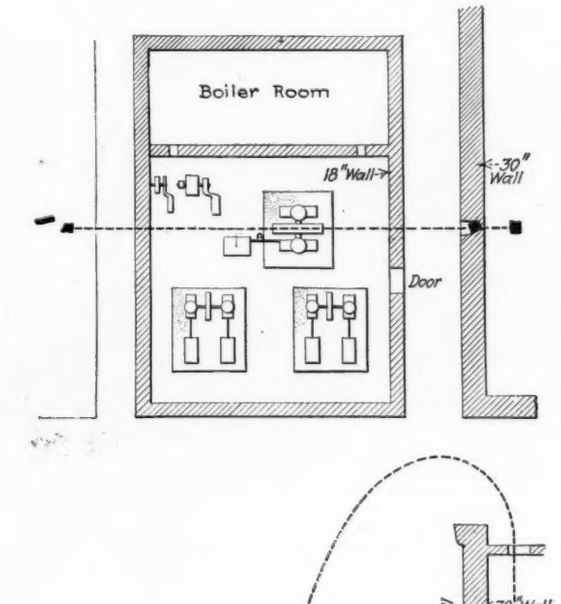


FIG. 1. PLAN AND ELEVATION OF PLANT, SHOWING DIRECTION TAKEN BY FLYWHEEL PARTS

The accident was caused by the working out of a small key, that fastened the bell-crank lever to the steam admission valve, on the crank-end when the admission valve was wide open, thus allowing the machine to run away and burst the flywheel by centrifugal force. As evidence that this was the cause, the feed water heater, which was out of the path of flying parts, was burst by the live steam pressure blowing through the exhaust port on the crank-end into it, the open steam valve permitting boiler pressure to follow the piston full stroke. The engineer observed the increased speed and attempted to stop the compressor, but the throttle was difficult to reach from the floor and hard to turn, and he was forced to leave before the throttle could be fully closed.

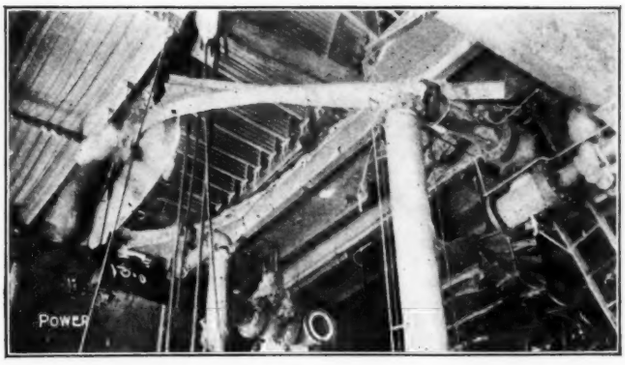


FIG. 2. WRECKAGE CAUSED BY FLYWHEEL EXPLOSION, LOOKING AT THE CONDENSER AND STEAM HEADER

When the flywheel burst, one piece weighing about three tons went through the second floor, which was of concrete, cutting off an 18-in. I-beam, then through an ammonia condenser and concrete roof and came down through the concrete roof, through the third floor and came to rest on the second floor of an adjoining building.

Another large piece went up on an angle of about 20 degrees through the 18-in. brick wall of the engine room and lodged in the 30-in. wall of a building across the alley. A third piece struck a 10-in. extra-heavy steam header and tore off a section about 10 ft. long, Fig. 2, stripping off the threads from the flanges and bending the pipe double. It then went through a window and out into the street followed by one of the spokes. Fig. 3 shows the wreck caused by the accident. The ice machine was wrecked, ammonia condensers demolished, electrical and other machinery damaged.

Breaking of the steam header and ammonia piping caused the loss of 10,800 lb. of ammonia in the system, valued at $2700. That everyone in the plant was not instantly killed by the liberated liquid ammonia is probably due to the strong chemical affinity that ammonia has for water. Fortunately the section of the wheel that cut the ammonia pipes also cut the steam main so that the liberated ammonia combined with the liberated steam vapor, thus forming aqua-ammonia and preventing the death of those about the plant. Some of the employees held their heads out of the windows, while others rushed to cold storage rooms and shut themselves in to escape from the deadly fumes. None of the seven men on duty were injured. The financial loss was fully protected under a policy of flywheel insurance carried by the Fidelity & Casualty Co., of New York. Under this policy the full amount of the loss, $13,423, was paid four days after the accident occurred.

Recent Court Decisions

Digested by A. L. H. STREET

Condemnation of Land by Power Companies—The validity of the Alabama law which authorizes a power company to condemn dam sites, water rights, etc., including water rights of factories in excess of the needs of such factories at normal stages of the stream, is sustained in a long opinion recently announced by the Alabama Supreme Court in the case of Alabama Interstate Power Co. vs. Mt. Vernon-Woodberry Cotton Duck Co., 65 "Southern Reporter," 287. The decision proceeds upon the theory that use of property to develop electricity for distribution to the public is a public use, within the principle of law that limits the right to condemn land to cases where public use is involved. In the same opinion the right of a foreign power company to condemn land under the law is recognized.

Seattle Can Sell Power—Sale of power is an incidental part of the Seattle city lighting department, according to the supreme court of Washington, in a decision handed down in the case of Albert Chandler and wife against the City of Seattle, validating the $425,000 bond issue authorized a year ago for the construction of an auxiliary steam power plant on Lake Huron.

Because of the failure of the Legislature to mention the word "power" in authorizing the city to issue bonds for the establishment and maintenance of a lighting plant, C. B. Masslich, of Caldwell, Masslich & Reed of New York, who have passed on all Seattle's securities, raised the question as to whether all light and power bonds should not be a charge against the 5 per cent. of the assessed valuation allowed for general fund purposes rather than against the 5 per cent. authorized for water, light and power purposes. Masslich suggested a friendly suit in order to determine this question.

This decision affirms throughout that of the King County superior court, upholding the validity of the light and power bond issues in question.

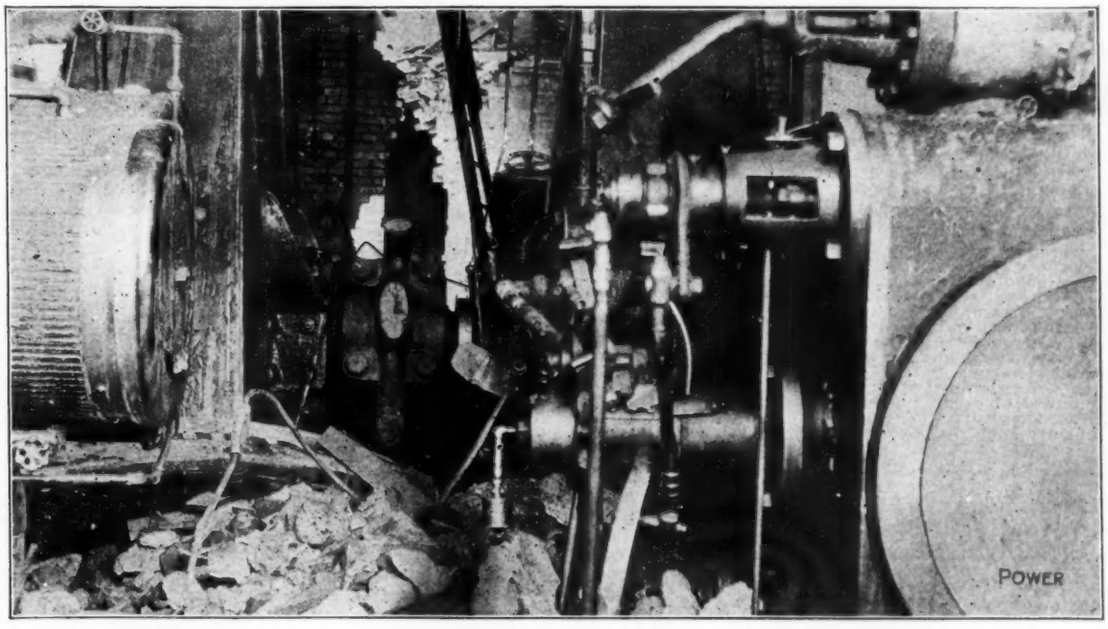


FIG. 3. ONE-HUNDRED-TON CAPACITY AMMONIA COMPRESSOR WRECKED BY FLYWHEEL EXPLOSION

Duty to Keep Electric Wires Insulated—An electric company which maintains wires extending through the branches of trees is bound to take notice of the habit of boys to climb trees, and must keep the wires insulated to avoid injury to trespassing boys. At least this is the holding of the North Carolina Supreme Court in the recent case of Benton vs. North Carolina Public Service Company, 81 "Southeastern Reporter," 448. The court recognizes in its opinion that this rule is not applied in all the states, but states that it finds support "not only in reason and a sound policy, but in a number of decided cases," including decisions of the highest courts of Mississippi, Kansas, Connecticut and Pennsylvania. In the North Carolina case it appears that the wire had been

insulated, but that it became uncovered through friction between it and the nearby branches of the tree.

When Private Power Plant Becomes a Public Utility—"A corporation, organized under a charter authorizing only mining and sale of coal and the exercise of rights incidental to such business, but nevertheless engaged in the work of supplying, from an electrical plant installed and maintained primarily for the operation by electric power of its mining machinery and the lighting of its stores, offices, and tenement houses, electricity for lighting purposes to practically all such persons resident within the incorporated town in which its stores and offices are located as apply for such service, at uniform rates of compensation, wiring their buildings for its use, and furnishing them fixtures, is a public service corporation, within the meaning of the Public Service Corporation Act, and so much of its business as is of a public nature is subject to control and regulation by the Public Service Commission." (West Virginia Supreme Court of Appeals, Wingrove vs. Public Service Commission, 81 "Atlantic Reporter," 734.)

Coal Not Warranted to Be Dry—When nut and slack coal is sold without any understanding between the parties that it is to be used in an automatic stoker, there is no implied warranty on the part of the seller that the fuel will be dry, so as to be available for that use, according to a recent decision of the West Virginia Supreme Court of Appeals, announced in the case of Buffalo Collieries Co. vs. Indian Run Coal Co., 81 "Southeastern Reporter," 1055. In this case it appeared that a selling company bought nut and slack from a mining company for delivery direct to its customers; that first deliveries made to an electric company for use in a power plant proved satisfactory, but that when the mining company installed a washer at its tipple, deliveries of wet coal proved unsuitable for use in the electric company's automatic stoker, and on that company's complaint the selling company obtained coal for its use elsewhere and sought to hold the mining company liable for the cost of this fuel in excess of the contract price, on the theory that the mining company had impliedly warranted that the coal would be dry and suited to use in an automatic stoker, but the court decided in favor of the mining company, saying:

This correspondence shows that the washed coal was better than the unwashed; that it contained more heat units, which is the most desirable quality in coal. It also tends to show that defendant regarded it of greater market value than the unwashed. The defendant's customer was the dissatisfied party, not defendant, and its complaint was not because of the quality of the coal. The gravamen of its complaint was that the washed coal would not work well in the automatic feeder, which carried the coal to the furnace. There is no evidence that plaintiff sold the coal with reference to its being used in any particular device for the handling of it, which required dry coal, and, therefore, there was no implied warranty that it would answer such purpose.

PERSONALS

W. O. Brooks was recently appointed operating engineer of the Abbeville (Ga.) Electric Light, Water & Power Co. Mr. Brooks succeeds J. J. Peterson.

E. E. Robinson is the recently appointed superintendent of the Southern Sierras Power Co.'s plant at Elsinore, Calif. P. L. Nourse was the former superintendent.

C. B. Arnold has been appointed operating engineer of the Intermountain Railway, Light & Power Co., Laramie, Wyo., This company is the successor to the Laramie Electric Co.

William Floyd Lee, chief engineer of C. W. Hunt Co., Inc., West New Brighton, S. I., N. Y., at a recent meeting of the board of directors, was elected vice-president and chief engineer of the company.

Jay G. Coutant, formerly engineer of plant of the Lima Locomotive Corporation, Lima, Ohio, who has specialized in the burning of powder fuel and water gas, has taken up the same work for the Railway Materials Co., Chicago, Ill.

Daniel Webster Mead, professor of engineering in the University of Wisconsin, Madison, Wis., has been appointed a member of a board of engineers for the prevention of floods in Eastern China through a $20,000,000 reclamation project.

Alexander G. Christie, associate professor of steam engineering, University of Wisconsin, has been appointed associate professor of mechanical engineering in the College of Engineering, which Johns Hopkins University is now organizing and building.

A. A. Potter, for several years professor of steam and gas engineering at the Kansas State Agricultural College, was made dean of the engineering division and director of the engineering experiment station of the same institution. Mr. Potter will still retain the professorship in steam and gas engineering.

OBITUARY

QUIMBY N. EVANS

Quimby N. Evans, senior partner of the firm of Evans, Almirall & Co., New York City, contractors for heating, ventilating and power equipment, died suddenly on Monday night, July 6. Mr. Evans was one of the old timers in the business, having been in partnership with Frederick Tudor in Boston as F. Tudor & Co., in the seventies. In 1880, he formed a partnership as the Q. N. Evans Co., doing business in Boston and New York, and in 1885 formed the Q. N. Evans Construction Co., in New York. In 1892 Mr. Almirall became associated with him, and two years later the present copartnership of Evans, Almirall & Co. was formed and has been in existence ever since. During the past few years Mr. Evans has not been actively engaged in the business, having felt that he could leave it in younger hands. His death was unexpected. Mr. Evans will be missed by a large circle of friends. The business of Evans, Almirall & Co. will continue as in the past.

NEW PUBLICATIONS

ELEMENTARY MANUAL OF THE STEAM ENGINE. By E. V. Lallier. Published by D. Van Norstrand Co., New York. Size, 5x7½ inches; 266 pages, illustrated. Price, $2 net.

From the title one would expect a treatise on the steam engine, but will find only about one-third the text covering this subject, the remainder being devoted to boilers, chimneys, pumps, steam turbines, pipes and fittings and internal combustion engines.

The method of treatment is first a description of the engine, followed by computations relating to its performance and then a brief but practical discussion of the fundamental theory. This order is the reverse of that usually found in textbooks, but has much to commend it to the practical man.

The part of the text dealing with the steam engine is good, in so far as it goes, the only criticism which might be offered being adherence to the old steam tables, based on Regnault's formulas, which have now been discarded by most authorities. Also, the author coins the expression "H. U." for heat unit, meaning a British thermal unit (B. t. u.), which might lead to confusion; and further classifies steam turbines under "rotary engines" in contradiction to the generally accepted definitions of these two types of prime movers.

The chapter on internal combustion engines contains many loose and misleading statements and might well have been omitted altogether. The only excuse for its inclusion would be its use to the operating engineer having charge of gas or oil engines, but it does not well serve this purpose since the gasoline engine is taken as the model with the statement that its description will cover all types.

NEW EQUIPMENT

ATLANTIC COAST

The Connecticut Co., Hartford, Conn., will make improvements to its power plant on Commerce St.

Bids will be received by E. C. Rider, Supt. Northern New York Institution for Deaf Mutes, Malone, N. Y., until July 22 for furnishing electric generating equipment at the institution.

Bids are being received by the Luna Park Amusement Co., Coney Island, New York, N. Y., for the construction of a complete power plant.

A municipal electric-light plant costing $30,000 will be constructed at Butler, N. J.

The Albion Light & Power Co., Albion, Penn., is in the market for a boiler and additional equipment. T. H. Flower is Treas.

Plans are being prepared by Jacoby & Weishampel, Commonwealth Bldg., Allentown, Penn., for the erection of a power station for the Panther Valley Electric Light Co., Lansford, Penn.

SOUTHERN STATES

The electric-light plant of H. A. Smith, Gurley, Ala., which was recently destroyed by fire, will be rebuilt.